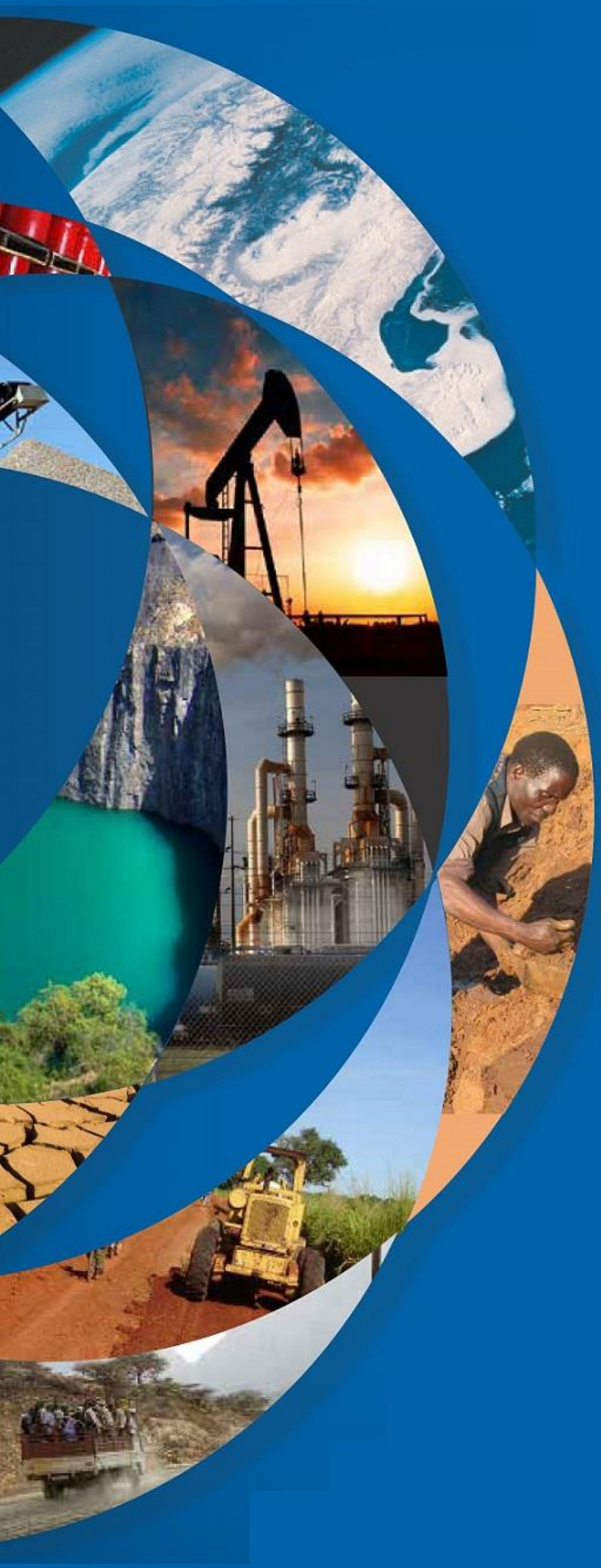

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Content

Morphological and interfacial studies of recycled concrete aggregates

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Abstract:

Recycled concrete aggregates considered to be a surrogate for natural aggregates brings along circumferential adhered mortar, inferior aggregate properties etc., which undermine the performance of concrete. This study highlights and discusses properties of recycled concrete aggregates that affect the performance of concrete at both macro and micro levels. Natural aggregates, untreated and beneficiated recycled concrete aggregates were used in study. Petrographic and Scanning Electron Microscopic (SEM) analysis was used to highlight various morphological disparities among natural and recycled concrete aggregates which might lead to undesired variations in concrete properties.

Different physical and mechanical properties of aggregate indicate toward an inferiority associated with performance of recycled aggregates, however beneficiation does improve the properties of recycled concrete aggregate. Petrological investigations showed similar mineralogical composition for natural and recycled aggregates indicating that the quality of recycled aggregate remains undeterred upon extraction from concrete waste. Concrete mixes incorporating such aggregates were studied to anticipate the suitability of recycled concrete aggregates for concrete applications.

Keywords: Recycled concrete aggregates, Morphology, Petrology, SEM, Beneficiation

Development of a new quiet particulate matter remover for indoor environment without using exhaust fans

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Abstract:

Purpose:

Due to the severe air pollution in China, air cleaners are equipped for indoor environments. For example, kindergartens, primary and middle schools usually use air cleaners to ensure children's safety during severe air pollution events. However, air cleaners on the market always include exhaust fans as a key component and generate loud noise. This aim of this study was to develop a new type of quiet particulate matter (PM) remover for indoor environment without using exhaust fans.

Method and Materials:

The developed PM remover module is composed of two parallel circular plastic plates with 16.5 cm in diameter. Four negative ion generators with stainless pins are fixed on one plate, and aluminum sheet is used to cover the other plate. Each remover module has a central hollow axis, which accommodates electric wires and allows multiple PM remover modules to be worn together like a sugar gourd. The PM remover was tested in different indoor environments including sealed plastic box, classroom, and wind tunnel.

Results:

The developed PM remover module needs an electric power of 3.84W under 12V and 0.32A direct current and passed all IEC safety requirement test. There was no ozone detected with a detection limit of 0.009 mg/m^3 in a 45 m^3 confined space with 20 PM removers on for 3 hours. In the 0.25 m^3 sealed plastic box, the times required for PM2.5 decreasing from 300 to 50 ug/m^3 were 261, 186, 147, 105, and 126 second when using one, two, three, four, and five modules, respectively. In the wind tunnel with 10 smoking cigarettes, PM2.5 behind the PM removers was 176±26 ug/m^3 without removers, 110±16 ug/m^3 with 25 PM remover modules, and 80±21 ug/m^3 with 50 PM remover modules. PM2.5 in the classroom with 60 PM remover modules was 42.8%±20.8% of the value in the control classroom. During school time

(8:30-11:30 AM and 2:30-5:00 PM), PM2.5 in the classroom with PM removers was 64.5%±15.0% of the value in the control classroom.

Conclusion:

We developed a new type of PM remover, which is quiet, safe, and assemble. Different number of modules can be worn together depending on size of the indoor environments for the best PM removing efficiency. The quiet feature specifically satisfies classroom requirement and has a great potential to protect children's safety during severe pollution events.

Keywords: Aerosol, PM2.5, Air cleaner, Indoor environment, Negative ion generator

Handling uncertainties inherited in field collected data for life cycle assessment of wastewater solid residuals treatment process

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Abstract:

Uncertainty is an unavoidable aspect of field collected data, because of the difficulties in accurately measuring many operational parameters such as daily solids production of wastewater treatment processes, and incomplete or limited recording of many field observed data. Although data uncertainty can have major impact on results of life cycle assessment (LCA), many LCA studies did not show adequate consideration how to evaluate, handle and reduce uncertainty for improved quality of LCA analysis. The objective of this study was to demonstrate how uncertainties in field collected data should be handled and analyzed, and how uncertainty analysis affects LCA results.

The developed procedures for uncertainty analysis consist of: (1) qualitative steps that include setting criteria about what data to be included in LCA inventory, how to characterize data, what criteria to use for differentiating between major and minor contributors in LCA modeling, how to evaluate data quality indicators, how to decide achievable alternative scenarios, and how to select most proper LCA method; (2) quantitative steps that include how to assign most appropriate estimated values for data gaps and most proper distribution of input data to LCA data inventory, and how to conduct probabilistic analysis to evaluate overall uncertainty.

As a case study, the procedures were applied to a LCA study on a full-scale wastewater solid residuals treatment process in St. Louis, USA. The study evaluated environmental performance of the existing treatment process (multiple hearths incineration) and two alternative treatment processes (fluid bed incineration and anaerobic digestion). The study revealed that variations in LCA results of the existing process ranged from 28.5% in the mineral depletion category to 110% in the radiation category, resulting in a variation of 40.6% for a single end-point score of 79.1 mPt. On the two alternative processes, it is 63.5% more probable that fluid bed incineration process would have less environmental impact that anaerobic digestion. The case study showed that the proposed qualitative and quantitative steps were able to address issues of data uncertainty. Monte Carlo simulation was able to quantify the overall data uncertainty to benefit comparative evaluation of alternative wastewater solid residuals treatment processes.

Keywords: Data uncertainty, Wastewater solid residuals treatment, LCA, Life cycle assessment

Optimization of a negative-ion-based quiet particulate matter removal module for indoor environment: Ozone emission and particle removal

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Abstract:

Purpose:

Due to the quiet and easy-cleaning feature, negative ion generators can be used for particulate matter (PM) removal for indoor environment without using exhaust fans or filters. Formation of ozone is of great concern for the application due to the high-voltage discharge electrode pins associated with such devices. This aim of this study was to optimize the distance between electrode pins and ion collection plate for minimal ozone formation and efficient PM2.5 removal.

Method and Materials:

The developed PM removal module is composed of two parallel circular plastic plates with 16.5 cm in diameter. Four negative ion generators with -DC8 KV stainless pins are fixed on one plate, and an aluminum sheet is used to cover the other plate for negative ion collection. The distance between the electrode pins and ion collection plate varies from 4 cm to 8 cm. The effect of pins-plate distance on ozone generation, negative ion current and PM2.5 removal were studied experimentally. Then we estimated ozone level and PM2.5 removal rate in a classroom, and compared them with real-time measurements.

Results:

When the pins-plate distance increased from 4 to 8 cm, negative ion current decreased exponentially, ozone formation decreased with a ladder-type pattern, while PM2.5 removal rate remained unchanged. The ozone emission rates for one PM removal module were 1.54 mg/h for 4 cm, 0.14-0.18 mg/h for 5 and 6 cm, and 0.03 mg/h for 7 and 8 cm. PM2.5 removal rates were 22.37, 18.29, 20.13, 19.66, and 18.43 /h for 4, 5, 6, 7, and 8 cm, respectively. If there were 60 PM removal modules with a 7 cm pins-plate distance were installed in a classroom, the ozone concentrations would be 44.8 ppb in 8 hours and PM2.5 level would be 1/2 to 1/3 of that in a control classroom.

Conclusion:

We optimized the distance between high-voltage discharge electrode pins and ion collection plate in a negative-ion-generator-based PM removal module with low ozone concentration (<50 ppb) and stable PM removing efficiency, which would improve the design of PM removal modules for indoor environments.

Keywords: Air pollution, Aerosol, PM2.5, Air cleaner, Ozone emission, Negative ion generator

Sustainability assessment of chemical production chains using system dynamics

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Abstract:

Sustainability for process industries is an important issue to resolve its high energy consumption, high emission and resource dependency problems. From the perspective of production chains, it is of great significance to investigate the relationships among the environmental, energy, water, and economic aspects. The aim of this work is to explore the sustainability for various scenarios of production chains based on system dynamics. After a better understanding of the mechanism of water/energy consumption, environmental impact, and economic aspects, the corresponding causality loops and system dynamics models are proposed to investigate the interactions of three subsystems. Five scenarios for long-term goals of production chain are simulated using system dynamics, including base case, resource recovery, energy comprehensive utilization, structural emission reduction, and sustainable development scenarios. The chlor-alkali production chain of 'coal - coke - calcium carbide - acetylene -polyvinyl chloride' is presented as the case study. The results showed that the sustainable development scenario has the priority to achieve the sustainability of production chains. This methodology can be used as a decision supporting tool for design, planning, and management of production chains in process industries.

Keywords: Production chains, System dynamics, Sustainability, Process industries

Resource efficiency assessment in integrated iron and steel plants through the industrial symbiosis and system dynamics approaches

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Abstract:

The iron and steel industry is known as a resource intensive industrial sector which has a strong involvement regarding environmental impacts reduction. Many attempts are continuously carried out in this field in order to improve the global resource efficiency of worldwide integrated iron and steel plants. In this framework and through this work, a particular focus is proposed to be made on industrial symbiosis where "the effluents of one process […] serve as the raw material for another process" (Frosch, 1989). This approach takes part in the circular economy and is being "today recognized as a path to improved operational performance as well as to improved environmental performance in situations where resource exchanges can be efficiently achieved" (Chertow, 2016). While going further in this field, the assessment of industrial symbiosis appears to be considered as a major step because "economic and environmental benefits are what comprise the core industrial symbiosis approach" (Chertow, 2016). Moreover, the methodologies used in this area traditionally end up with a "static" point-of-view whereas industrial symbiosis tends to be defined and further evaluated as a "dynamic" problem (Chertow, 2012).

That is the reason why, the dynamic evaluation of economic and environmental performances of industrial symbiosis is presented in this work through scenarios involving a typical integrated iron and steel site. With this purpose, a system dynamics model is built using causal loop and stock and flow diagrams based on resource streams (e.g. physical and “negative” resources). This model gives a detailed overview of the relationships between the core variables that define the industrial symbiosis system structure. Through dynamic simulations, this model further depicts the impacts of industrial symbiosis scenarios on the steel manufacturing processes, including: coking, sintering, iron-making, steel-making, continuous casting, hot rolling and electricity production in a power plant. Environmental and cost benefits are thus quantified and highlighted over time in order to assess the resource efficiency of these processes. These simulations especially allow analyzing how any decision regarding industrial symbiosis can affect the efficiency of a typical iron and steel plant in term of physical resource uses (e.g. energy, water, raw materials and by-products) as well as “negative” resource releases (e.g. carbon dioxide emissions and waste).

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Chertow, M., Park, J., 2016. Taking Stock of Industrial Ecology. Scholarship and Practice in Industrial Symbiosis: 1989-2014. Chapter 5, 87–116. *Springer International Publishing.*

Frosch, R. A., Gallopoulos, N. E., 1989. Strategies for manufacturing. *Scientific* American, 261(3), 144–152.

Keywords: Circular economy, Industrial symbiosis, Resource utilization efficiency, Resource utilization environmental impacts

Products and metal stock accumulation and socio-economic drivers of Chinese megacities: A bottom-up analysis

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Abstract:

Urbanization has rapidly developed in China since 1978 and huge quantities of metal have accumulated in Chinese megacities. Accounting metal stock is the basis for forecasting metal demand and obsoleted metal production in the future. A dynamic bottom-up analysis is applied in this work to estimate metal stocks in Chinese megacities in the period of 1980-2014, including five categories (buildings, infrastructure, machinery, domestic appliances and transportation equipment), three types of metals (iron and steel, copper and aluminum) in ten Chinese megacities (Beijing, Shanghai, Tianjin, Chongqing, Nanjing, Chengdu, Guangzhou, Shenyang, Shenzhen and Wuhan). Socio-economic driving forces, uncertainty, a more precise spatial boundary and implications behind MS variation also probed. Important findings are (1) Similar pattern of increasing metal stocks appeared in ten Chinese megacities since 1980 and Shanghai turned out to be the largest metal reservoir (68 million tons in 2014) and Nanjing become the largest MS/cap (0.9 t/cap in 2014) since 1991; (2) Iron stocks is the dominant part of MS which contributed over 90%. Building stocks substituted machinery and became dominant component of total MS while residential building stocks substituted industrial machinery in subcategories; (3) economy has always been the main driving force of MS growing and growth of categories are relevant with each other.

Keywords: Metal stock, Bottom-up, IPAT, Uncertainty

From enterprise to industry's viewpoint: The energy, environmental and economy (3E) assessment on lithium-ion battery products in China

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Abstract:

The development of lithium-ion battery (LIB) industry is booming in China, though the LIB itself is better for environment than other batteries, LIB enterprises still bring lots of environment problem such as energy consumption, pollutant emission and the generation of greenhouse gases. The research will focus on the lithium-ion battery's relatively comprehensive environmental impact, from two aspects as enterprise and product. By Energy, Environment and Economy (3E) analysis and calculation of raw and auxiliary materials' carbon footprint (CF), some conclusions about LIB enterprises and batteries are arrived.

In terms of three LIB enterprises researched, the production of one lithium iron phosphate battery will consume the most electricity and water resources, produce air pollutants NMP 0.08g, water pollutants COD 0.75g and NH3-N 0.17g, household waste 13.89g, ordinary industry waste 0.06g and hazardous waste 2.83g. While one polymer LIB's production consumes the least electricity and water resources, exhausts NMP 0.02g, COD 0.15g, NH3-N 0.01g, household waste 10g, ordinary industry waste 1.11g and hazardous waste 1.09g. Finally, one semi-manufactured LIB's production exhausts NMP 0.008g, COD 0.17g, NH3-N 0.03g, household waste 5.62g, ordinary industry waste 0.55g and hazardous waste 0.45g. The energy consumption and environmental pollution are both closely relevant to company scale and battery type, the research reveals that the production of lithium iron phosphate battery might consumes more resources and exhausts more environmental pollutants than other batteries, polymer LIB's production process may be more resource-saving and eco-friendly. Besides, three enterprises' proportion of green investment are respectively 2.52%, 2.04% and 0.71%, by comparison above results, it shows that environmental protection investment is roughly proportional to the level of pollution, which may be also associated with battery type or the scale of company.

For two kinds of battery products, one lithium iron phosphate battery researched will use more raw and auxiliary materials than one polymer LIB researched, and the CF of a former battery is 0.545 kg CO_2 eq, the CF of a latter battery is 0.308 kg CO_2 eq. For the lithium iron phosphate battery researched, the CF of lithium iron phosphate is 49% of total CF, the CF of diaphragm account for 26%, the CF of copper material and graphite respectively account for 9% and 10%. For the polymer LIB researched, the CF of lithium cobalt oxides is extremely high and the proportion is 67%, the second biggest contributor to the CF is diaphragm whose proportion is 16%, other materials'

total proportion is 17%, among them the CF of copper material and graphite respectively account for 5% and 7%. It reveals that the CF of one lithium iron phosphate battery researched are higher than polymer LIB', and the main CF contributor for two kinds of battery are lithium materials and diaphragm.

Keywords: Lithium-ion battery, Enterprise, Product, 3E analysis, Carbon footprint

Time-of-use pricing and investments in energy efficiency and solar panels

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Abstract:

The penetration of energy efficiency and solar energy in residential sector is still relatively low at present. Electricity rate structure has potential influence on energy efficiency investments and solar panels adoption. This paper compares energy efficient appliance and solar panel investments between consumers on flat electricity rates and those on Time-Of-Use (TOU) rates in Phoenix, Arizona in 2014, based on data from 8000 electric customers. We first build a theoretical model to show that TOU customers have more incentives to adopt energy efficiency and solar panels. Then probit model and multinomial logit model as well as matching approach are employed to provide empirical evidence. We use propensity score matching and coarsened exact matching to match the treatment group with the control group. Empirical evidence also confirms that TOU consumers are more likely to install solar panels, but there is no evidence that they are also more likely to purchase energy efficient AC. The findings highlight that rate design could act as a policy instrument to facilitate renewable energy adoption.

Keywords: Electricity pricing, Energy efficiency, Solar panels

Material footprint and business cycle: A missing link in addressing resource sustainability?

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Abstract:

Economy-wide material flow forecasts are crucial for future strategy-setting and policy-making. Existing studies are mostly focused on the relationship between material footprints and the long-term trend of economic growth, but ignore the business cycle, i.e., the short-run economic fluctuations around the growth trend. Failure to account for business cycles in the forecasts may lead to an overestimate or underestimate of the predicted cumulative material flows. Neglecting the interaction between Business cycles interact with resource policies may lead to sub-optimal policies and extra welfare losses. Based on the synthesis of industrial ecology, macroeconomics, and the emerging literature on business cycles and the environment, we attempt to answer two basic questions: (1) Are the material flow variables procyclical or countercyclical? (2) Do the material flow variables respond symmetrically or asymmetrically to the business cycles? With time-series econometric techniques, we examined the procyclicality of material flow variables and the asymmetric response of material flow variables of each qualified country in the Global Material Flow database. We found that for the majority of countries, material flow indicators were procyclical: they exceed the long-term growth trends during economic booms while falling below trends during economic recessions. For the majority of countries, the responsiveness of material flow indicators to economic fluctuations were different during economic expansions and recessions. Our study reveals the procyclical and asymmetric nature of material flows responding to business cycles, which adds new layers of uncertainty to their forecasts. It reminds the policy-makers that the timing of carrying out resource policies in light of macroeconomic climate matters for their actual effects in reducing material footprints and improving social welfare.

Keywords: Material footprint, Business cycles, Economy-wide material flow accounting, Industrial ecology

Temporal evolution of nitrous oxide production and emission in China: Assessment, strategy and recommendation

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Abstract:

Following carbon dioxide (CO_2), methane (CH_4) and chlorofluorocarbon-12, nitrous oxide (N_2O) is the fourth most important anthropogenic greenhouse gas and it is a reactant in the destruction of stratospheric ozone, which is expected to remain the largest throughout the 21st century. Atmospheric N_2O concentrations have been increasing as a result of extensive use of synthetic fertilizers and synthetic nitrogen products in response to growing human population and rising living standards. Limiting future N_2O emissions and reducing the anthropogenic forcing of the climate system would be very imperative for both ozone and climate. Nowadays, due to the large-scale expansion of agriculture and the rapid development of industry, China has become a hot spot of N_2O emissions. To map the potential towards reducing N_2O emissions, a high-resolution insight and a historical overview of the N_2O streams are pivotal. This study provides a substance flow analysis for N_2O emissions based on life cycle thinking, which focuses on agriculture, industry, human consumption, waste management, atmosphere and hydrosphere subsystems at large-scale in China from 1978 to 2014. Based on the composite framework, historical reconstructions of atmospheric N_2O and its inferred anthropogenic sources are estimated (Assessment). Moreover, we investigate future scenarios that could minimize total N_2O emissions while meeting the demand for nitrogen products (Strategy). Finally, we provide some future mitigation strategies for reducing N_2O emissions to the environment (Recommendation).

Keywords: Nitrous oxide, Greenhouse gas, Temporal evolution, Scenario analysis, Policy implications

Analyzing spatial characteristics and dynamic changes of air-pollutant emission inventory in Chinese steel industry based on the "bottom-up" approach

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Abstract:

As one of the intensive energy-consumption and high pollution industries, the steel industry is facing a severe test of energy-saving and emission-reducing. In this regard, this paper analyzed the product structure and output of steel industry, produce-processes, produce-equipment, product capacity, and the technology level of controlling pollutants. Accordingly, based on the "bottom-up" approach we established the database of steel-industry's activity levels and emission factors about air-pollutants in China. Finally, by means of the emission factor method, air-pollutant emission inventory of Chinese steel industry was built to analyze its spatial characteristics and dynamic changes. Results show:

First of all, in 2015, the total amount of SO_2, NO_x, PM, PM2.5, PM10 and PCDD/Fs emission from Chinese steel industry were 1697.58kt, 1017.24kt, 4028.01kt, 849.02kt, 1330.53kt and 1216.83g I-TEQ, respectively in which SO_2, NO_x, PM, PM10 and PCDD/Fs emissions mainly came from the sintering process, and PM2.5 came from the converter process. At the same time, PM, PM2.5 and PM10 mainly came from non-organizational emissions, reached 3015.68kt, 580.53kt and 838.77kt respectively, accounting for 74.87%, 59.87% and 63.04% in the total emissions of PM, PM2.5 and PM10 from Chinese steel industry.

What's the most important is that the emission inventory of air-pollutants from Chinese steel industry indicates obviously spatial characteristics. Among the 6 regional areas of China (including North China, Northeast China, East China, Central South China, Southwest China and Northeast China), the steel industry in North China and East China showed the most serious air-pollutants emission. Taking SO_2 emissions in 2015 as an example, we found that SO_2 emissions from steel industry in North China and East China were 1006.63kt, accounting for 65.2% of the total emission. Especially, SO_2 emissions from steel industry in Hebei, Jiangsu and Shandong provinces, in which there were too many steel enterprises produce the majority of steel products, were up to 404.04kt, 171.83kt and 156.28kt respectively, accounting for 23.80%, 10.12% and 9.20% in Chinese total emissions.

What's more, in temporal changes there are three kinds of obvious trends of air-pollutant emissions in Chinese steel industry. The first one is the "always-growth" trend represented by NO_x which mainly resulted from the over-growth of the steel output. The second one is the "slowdown" trend represented by SO_2 emission. Although it was also negatively affected by the over-growth of steel output, more

measures and technologies of energy-saving and emission-reducing vigorously dedicated to the decrease of SO_2 emission; The third one is the "firstly up, then down" trend represented by PM, PM2.5, PM10 and PCDD/Fs, which is a gratifying achievement of promoting the clean production in China's iron and steel industry. Finally, based on the system dynamics and the principle of air-pollutants emission from steel industry, the simulation model of air pollutants (SO_2, PM) is established to analyze the adjustment of production capacity and layout of steel industry. In the next few years, the emission of atmospheric pollutants will decrease obviously, and the SO_2 and PM emissions will be reduced by 1 million tons and 2 million tons respectively.

Keywords: Steel industry, Air pollutants, Emission inventory, Spatiotemporal characteristics

Estimating circular agricultural environmental impact using life cycle assessment approach

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Abstract:

At present, as the specific operation mode of the agricultural sustainable development, the research and practice of circular agriculture has become a hot topic in the field of agriculture in China. It is undeniable that along with the economic development, the problems of environmental pollution and resource depletion are also reflected in the process of agricultural production similarly. However, little research has been done on quantifying the potential harm to the environment during the operation of circular agriculture and even blindly believing that "zero emissions" of circular agriculture, which have greatly restricted the sustainable development of circular agriculture. How to reasonably evaluate the potential impact on the environment in the process of circular agriculture has become key point to promote the sustainable development of circular agriculture. Based on this consideration, this article takes the circular agriculture industry demonstration site of Xingyuan, Fuqing City, Fujian Province as an example and evaluates the potential impact of circular model of Pig farming industry-Dragon fruit planting-Forage planting-Fishery industry-Mushrooms planting-Biogas generation-Organic fertilizer from the perspectives of environmental and environmental-economic point of views compared with the main industrial model-pig farming industry. Moreover, this paper finds the key elements that restrict the development of circular agriculture model through sensitivity analysis in order to explore the effective ways to reduce the potential environmental impact of the whole circular agriculture from the perspective of "reduction ring" and maintaining the current recycling model. The results show that if we simply consider the potential environmental impact, the circular agriculture is no better than the main production model of pig farming industry. And if considering reducing the potential environmental impact as well as improving the economic benefits of the environmental emissions of the whole circular agriculture from the perspective of "reduction the ring", we can consider remove mushrooms planting and organic fertilizer out of the circular framework. Moreover, if we want to reduce the potential environmental impact of circular agriculture without changing the current recycling model, the results show that we can focus on the premix, especially the main three components of corn, soya bean meal and whey protein concentrate.

Keywords: Circular agriculture, Environmental assessment, LCA analysis, Sensitivity analysis, Sustainability

Forward and backward critical sectors for CO_2 emissions in China based on eigenvector approach

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Abstract:

From 2007 to 2012, great change has been witnessed in Chinese economy, as well as its carbon emission performance. This study gives forward and backward perspectives into the key sectors of China, including a forward view that reflects the pushing effect of supply side and a backward one that describes the pulling power of demand side. Based on the input-output table of China and the sectoral CO_2 emissions, an environmental input-output table was established. Then, we used the eigenvector approach to figure out the key sectors that push or pull the CO_2 emission of the whole economy. Of all the 30 sectors, the electricity and hot water production and supply sector and the coal mining sector stood as the top 2 pushing sectors respectively in 2007 and 2012. While on the demand side, the electricity production and supply sector also stands as key sector, and the gas and water production sector and the metal mining sector had the largest power of pulling the overall carbon emission among the economy. During the 5 years, most of the key pulling sectors remained stable in their impact weight, in which the pull from the nonmetal mining sector surpassed the petroleum and gas extraction sector and the gas and water production sector, notably. In 2012, the electricity production and supply sector played the top puller and the second pusher in the whole economy and the sectoral network. Specifically, it contributed 94.1% directly and indirectly in its own emission, and its demands also provided over 30% of pulling effect to the CO_2 emissions of sectors including the metal mining sector, the gas and water production sector, the nonmetal mining sector, and the petroleum and gas extraction sector; its production played a dominant role (more than 80% power) in pushing the CO_2 emission from the coal mining sector, the petroleum refinement and coking sector and the electrical equipment sector. Based on those, policy suggestions could be considered. Generally, each sector should control its direct CO_2 emission first; and the electricity production and supply sector should be optimized for the indirect CO_2 reduction of relevant sectors and the carbon reduction of the whole economy.

Keywords: CO_2 emissions, Power-of-pull approach, Input-output analysis, Climate change

Intra-and intergenerational equity based equilibrium approach towards sustainable water resource management

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Abstract:

In this study, an equilibrium approach based on intra-and intergenerational equity was applied to deal with the water shortage problems and reconcile the conflicts increasingly lead by water scarcities between water users of both present and future generations. Guided by the spirit of sustainability, a systematic decision making framework was developed to support water resource utilization and protection through allocating it to right users in the right amounts at right time and assist decision makers better understand the trade-offs between economic development, population growth, and water resource management. In the water resource management system, decision makers in different power levels act as leader and followers with different goals and preferences. Similar to a Stackelberg-Nash game, in the water allocation process, the decision making feedback and conflict coordination between the authority and water users, and between two generations were illuminated for enhancing sustainable development and stability. To response the challenges in the future climatic and hydrological uncertainty, assessment of the impact of climate change on water allocation strategies and potential consequences of social-economic development was conducted. A case study of Minjiang river in China was presented to demonstrate the practicality and efficiency of the optimization model. Based on the scenario analyses and discussion, some propositions and operational policies are given with sensitive adaptation strategies suggested to support sustainable water development.

Keywords: Intra-and Intergenerational Equity, Sustainability, Conflict, Water Allocation

A symbiosis-based life cycle management approach for sustainable resource flows of industrial ecosystem

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Abstract:

It is fundamental to sustainable industrial development that resource flows keep continuous trait from nature to industrial ecosystem and back to natural cycles within environmental carrying capacity. Traditional separated management method leads to unsustainable resource flows due to the linear flows, which are the root cause for severe environmental problems and resources shortage. Shifting the intermittent or linear trait of the resource flows to more continuous and circular flows is a tremendous challenge in the industrial ecosystem for the sustainable management of resources. Existing research mainly focuses on improving the efficiency of resource use or reducing waste, but there is a lack of systematic management research on resource flows from the perspective of the industrial ecosystem. Thus, we explore a life cycle management (LCM) approach based on life cycle thinking and the industrial symbiosis mechanism. By clarifying the life cycle system of resource flows and the symbiosis pattern, we establish the framework of LCM for cyclic resource flows. Based on the framework, a symbiosis-based LCM approach with the integrated assessment system and targeted management is proposed for sustainable resource flows. The case study demonstrates the ability of the approach to provide a flexible and effective management to achieve sustainable resource flows in the industrial ecosystem by helping decision makers identify the key issues and generate the targeted integrated strategies from a life cycle perspective.

Keywords: Industrial ecosystem, Symbiosis, Life cycle management, Resource flows

Projected air quality benefits from policy interventions in India

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Abstract:

Air pollutants, especially particulate matter with aerodynamic diameter of 2.5 μm or less (PM2.5), have been an urgent environmental problem to India in recent decades due to its significant impacts on human health. In this study, Community Multi-scale Air Quality (CMAQ) model was applied to simulate potential impacts on air pollutants based on future government controlling strategies in India by 2030. Thirteen scenarios based on different potential emission control strategies towards energy, residential, agriculture, industrial and open burning were simulated and compared with current emissions. The spatial and temporal variations of NO_2, SO_2, O_3, as well as PM2.5 and its components such as primary particulate matter (PPM), secondary inorganic aerosol (SIA) concentrations in India were analyzed in all scenarios. The potential health effects of emission control measurements by 2030 are also evaluated against current levels. Results from this study can help to assess outcomes of air pollution control strategies and provide precious information for health impacts on air pollution in India.

Keywords: Air quality, Policy intervention, PM2.5, Mortality, India

Low-carbon roadmap for thermal power sector in China: Technology development analysis

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Abstract:

Climate change, a global issue exerting heavy influences on the whole world, has brought great pressure to China as well. Low-carbon technology is critical to develop low-carbon economy, and rational planning of low-carbon technology roadmap plays a guiding role in the development of the low-carbon industry. Due to the uncertainty of the conventional low-carbon technology roadmap based set on qualitative analysis and the complexity and time-consuming based set on typical bottom-up models, we present a new method to analyze low-carbon technology roadmap in order to achieve a low carbon scenario for China. Three types of economic and social development-technology combination scenarios are defined in this paper. Based on system dynamics theory, the carbon reduction model is established to simulate the trends of carbon emissions and carbon emission intensity. Combined with the technology capacity cost from the cost curve and the coal consumption cost related to power generation, carbon emissions reduction cost of each scenario is calculated. And then based on the technology life cycle theory and simulation results, combined with government planning, market and other factors, policy recommendations of low-carbon technologies roadmap are put forward. The results show that there is a large possibility of controlling CO_2 emissions after 2025 and preventing the significant increase for China. The technology development policy should be combined with the policies for boosting economic development and addressing climate change. The application and extension of a series of technologies discussed in the thermal power industry is directly related to the low-carbon energy development path of China. The abatement policies vary in intensity at different stages for purpose of minimum unit cost.

Keywords: Roadmap, Low-Carbon technology, Combination optimization, Carbon emissions, Cost

Pattern changes of Chinese energy consumption in the new economic development phase

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Abstract:

Energy consumption is highly connected with economic development. China has entered a new phase of economic development – a "new normal", in which large-scale, rapid and multidimensional changes in economic structure are happening. This study aims to estimate the patterns of Chinese energy consumption in the new phase. We use the Structural Decomposition Analysis (SDA) and Environmentally Extended Input-Output Analysis (EEIOA) to decompose China's energy consumption changes during 2005-2012. During the period of the global financial crisis, energy consumption induced by China's exports dropped, whereas energy consumption induced by capital formation grew rapidly. In the new normal, the strongest factors offsetting China's energy consumption have been shifting from efficiency gains to structural upgrading. Efficiency was the strongest factor offsetting China's energy consumption in traditional development model, but its effects have become weak in the new normal. By contrast, as the factors increasing China's energy consumption in traditional development model, production structure and consumption patterns have started to offset China's energy consumption in the new normal. In addition, China's energy consumption tends to shift from an investment to a consumption-driven growth model.

Keywords: Energy consumption, Financial crisis, New normal, Structural Decomposition Analysis, Input-Output Analysis

Simulation and analysis of co-benefit of carbon dioxide and air pollutant emission reductions by the air pollution prevention and control action plan in the Beijing-Tianjin-Hebei region of China

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Abstract:

Air pollution problems have become very severe in the Beijing-Tianjin-Hebei region of China due to large amount of air pollutant emissions from intensive fossil fuel consumption. Meanwhile, fossil fuel consumption also emits carbon dioxide (CO_2) which is a greenhouse gas and causes climate change. Chinese Central Government has set up the Air Pollution Prevention and Control Action Plan, aiming to reduce air pollutant emissions significant through using cleaner energy, industrial upgrading, eliminating high energy consumption industries, and etc. These actions also have potential in reducing CO_2 emissions. In this study, we calculate the synergistic effects of the actions in the plan on main air pollutants and carbon dioxide emissions. The objectives include quantitative analysis of the co-benefit from different industries by different measures for different pollutants in the plan.

The Greenhouse gas-Air Pollution Interaction and Synergies model (GAINS) is used in this study. According to each measures in the action plan, new scenarios with modified activities, energy consumptions, the influence of policy, and the equipment levels are generated in the model. The reductions in the air pollutants and CO_2 then are simulated for each of the measures. The results indicate that the potential CO_2 emission reduction in Beijing and Tianjin from the measures of reducing coal-fired power consumption is 9.2Mt/year and 4.2Mt/year, respectively. In Hebei, the CO_2 emission reduction potential of industrial facilities is the largest, up to 122.5Mt/year. Measures for coal combustion power plants in Beijing contribute the most carbon dioxide emission reduction, accounting for 48% of the total CO_2 reduction in Beijing. Measures for industries in Tianjin contributes the largest, reaching 42%. Among the main air pollutants, the co-benefit carbon dioxide emission reduction is the highest with NO_x in Beijing, is the highest with PM2.5 in Tianjin and Hebei.

Keywords: Air pollutants, Carbon dioxide, Co-benefit, Control measures

Treatment of mercury contaminated soil with sulfur-modified rice husk biochar: Stability under accelerated ageing

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Abstract:

Mercury (Hg) pollution in surface soils has become a major global issue, particularly in the developing world. It is imperative to develop new, effective, and preferably 'green' remediation technologies to protect human health and the environment. Previously, it was revealed that S-modified rice husk biochar has great potential to stabilize Hg and can be applied as a 'green' method for the remediation of Hg contaminated soils. This technology promises high Hg adsorption capacity, without the high economic costs and secondary environmental impacts of sorbents such as granulated activated carbon (GAC), nor the toxicity of thiol-modifying compounds. However, due to a lack of experimental evidence, the practicality of this novel technology for the long-term treatment of Hg contaminated soils remains uncertain. The present study was undertaken to examine Hg stabilization efficiency under simulated accelerated ageing conditions. This was achieved by subjecting treated soil samples to wet-dry cycles that represent rainfall acid loading over time. Our results demonstrate the simulated life-span of the treatment by measuring the bioavailability of Hg, and the leaching of sulfur from the modified biochar, periodically. Moreover, the form of Hg in the aged soil was assessed by sequential leaching to demonstrate its residence as an immobile Hg-sulphide phase.

Keywords: Biochar, Sustainable remediation, Soil pollution, Contaminated land, Mercury (Hg)

Biochar production for valorizing and reusing agricultural residues on-site: A critical review of processes, opportunities, and challenges

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Abstract:

Uncontrolled open burning of unwanted agricultural residues is often performed at small-scale farms, resulting in resource wastage and substantial air pollution. Alternatively, residues can be valorized by producing biochar. When returned to land, biochar may improve certain soil properties such as, pH and soil texture, which, subsequently, may improve crop yields and/or reduce contaminant heavy metal(loid) uptake. The valorization and reuse of agricultural residues in this way embodies a desirable regenerative system, where farming resource inputs, wastage, and emissions can be minimized. However, whilst certain feedstock materials and pyrolysis conditions may produce biochars that perform well in improving soil properties, it has been found that some others perform poorly. The relationship between the properties of biochar and their production methods remains unclear. Moreover, different biochar production methods represent different advantages and disadvantages. To help address these issues, this paper critically reviews various technologies and techniques for preparing biochar from agricultural residues. A statistical analysis of published data reveals how pyrolysis conditions may affect certain biochar properties, and the effects on soil physical and chemical properties are explored. Recommendations are put forward for optimally producing biochar from agricultural residues, and future research needs in this field are identified.

Keywords: Biochar, Heavy metals, Sustainable remediation, Literature review, Crop residue

Uncertainty resource utilization due to the choices of life cycle impact assessment methods

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Abstract:

Environmental Life Cycle Assessment (LCA) is a useful tool to evaluate the environmental impacts through the life cycle of producing a product or during a process. As a stage in LCA, Life Cycle Impact Assessment (LCIA) is designed to quantify environmental impacts such as resource utilization. To estimate the impacts, existing LCA tools/software allow users select different life cycle impact assessment (LCIA) methods to analyze environmental impacts from different perspectives. Different LCIA methods have been developed over the years; they differ in many aspects, such as characterization factor values and the coverage of substances. LCA tools/software often embed one or more LCIA methods and provide features to allow users to select one method at a time to calculate the final environmental impacts. These features often make the LCIA analysis efficient and straightforward to the users; however, the uncertainty due to the choice of different LCIA methods based on particular products has been analyzed for years. In our study, we seek to evaluate the uncertainty of LCIA results of all processes in the US LCI and Ecoinvent database, by using all LCIA methods provided in the SimaPro software.

First, we analyzed the uncertainty caused by using 14 LCIA methods provided in the Simapro software. We used example products to show how the results of resource utilization are different based on different LCIA methods. Then, because LCIA methods differ in the values of characterization factors and coverages of substances, we analyzed the contributions of the uncertainty from coverages of substances and the values of characterization factors.

The impact results calculated from different methods show that the discrepancies can be large. The sources of discrepancies can be traced to different coverages and characterization factors in the substances. The wrong choice of a method may result in wrong decisions. We use the results to emphasize the importance of considering all LCIA methods while evaluating environmental impacts such as resource utilization.

Keywords: Life Cycle Assessment (LCA), Life Cycle Impact Assessment (LCIA), Uncertainty, Environmental impacts, Resource utilization

Effectiveness of sustainable materials as binding agents in soil stabilization of arsenic and antimony

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Abstract:

Stabilization is one of the most widely used conventional remediation technologies for treating heavy-metal contaminated soil. It offers great advantages in cost-effectiveness, flexibility, fast implementation and less secondary pollution. By adding certain stabilization material, soil contaminants are converted to forms that are less mobilized and soluble. Traditionally, bitumen emulsions and cement are used as binding agents in stabilization techniques. However, bitumen and cement are neither environmentally friendly nor sustainable. The reuse of industrial wastes as remedial materials in amending contaminated soils is regarded as a green and sustainable approach in soil remediation. However, due to the lack of experimental evidence, the effectiveness of such stabilization materials remains uncertain on the site remediation projects. The present study was undertaken to find out the most effective binders over a range of sustainable stabilization materials, in treating an arsenic (As) and antimony (Sb) contaminated mining site. These materials are form industrial wastes, including lime, red mud, hematite, goethite, limonite, magnetite, magnesium mine deposits and steel-making deposits. The stabilization performance of these binding agents were comprehensively discussed based on TCLP, sequential leaching and microstructural analyses. This work aids future application of green and sustainable materials in soil remediation.

Keywords: Green and sustainable remediation, Soil remediation, Stabilization, Arsenic, Antimony, Mining

Evaluating environmental protection strategy in printed circuit board manufacturer using fuzzy importance performance analysis

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Abstract:

Printed circuit board (PCB) is one of very important material in consuming electronic product. The process of PCB usually uses chemicals and large quantities of water are need. PCB manufacture devotes improve the process for conform the environmental protection rules and regulations. However, the evaluating of performance in environmental protection strategy is very hard by quantitative method. Therefore, this study attempts to evaluate the environmental protection strategy in PCB manufacturer using fuzzy importance-performance analysis (FIPA). The empirical example presents the “Specialized staff assists employees to understand environmental protection rules”, “Environmental protection measures of products for various customers”, and “Using advance sewage treatment technology” should be prior concerned in PCB manufacturer based on FIPA method.

Keywords: Printed circuit board, Environmental protection, Fuzzy importance-performance analysis

Climate change effect on China's rice production, trade and self-sufficiency: A comparison between PE and GE in GTAP model

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Abstract:

As the basic food of human life, China's effort to maintain the target self-sufficiency rate of rice could be harder facing the future global warming. This study, based on GTAP model with PE and GE closure, analyzed the impact of global warming on rice self-sufficiency and its different influence mechanism. Results revealed that: The land input of paddy and the share of paddy input in rice has influenced prices of rice and its competitiveness in the global market. Prices in South Korea has risen the most (8.52%, PE; 7.11%, GE) with the output fell (-0.78%, PE; -0.74%, GE). For China, the prices have risen 3.29% with a grown yield 0.02% in PE, while a 2.47% rise in price and a 0.18% fall in output in the GE. The self-sufficiency rate is decomposed into the contribution of output and trades, while the latter is more influential shown in the result both in comparing the discrepancy among regions or between PE and GE. The self-sufficiency rate of rice in USA has the highest increase (2.91%, PE; 2.15%, GE) because of the expanded export, the same as China with a slight rise (0.016%, PE; 0.006%, GE). The South Korea has been damaged most due to the large growth of import.

Keywords: Climate change, PE&GE, GTAP model, Rice, Self-sufficiency

Measurement and evaluation of urban eco-innovation efficiency in China

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Abstract:

To improve the urban eco-innovation efficiency is of great significance to realize the sustainable development of the city. Considering the impacts of scientific & technological innovation and environment protection on urban development, this paper introduces science & technology and ecology to the indicator system to evaluate urban eco-innovation. Based on the panel data of 16 national innovation-oriented pilot cities in China between 2006 and 2015, the urban eco-innovation efficiency was measured by the super-efficiency DEA and its influencing factors were analyzed using the Tobit model. The results show that the eco-innovation efficiency of most cities is fluctuating, generally in an upward trend, but the eco-innovation development of these cities is not balanced. The eco-innovation efficiency of cities in the central and western regions grows faster though there is still a gap with the eastern coastal cities. Excessive emissions and irrational labor input are the dominant factors to restrict the increase of urban eco-innovation efficiency. Both the level of urban culture and the degree of urban openness have significant positive effects on urban eco-innovation efficiency, and the effect of the latter is more prominent.

Keywords: Eco-innovation efficiency, Super-efficiency DEA, Panel Tobit model, Influencing factors

Downscaling shared socioeconomic pathways from global to local: Application to future wood outtakes in the Norwegian forestry sector

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Abstract:

The forest sector plays a key role in achieving low temperature stabilization targets, as woody biomass represents a cost-efficient alternative to fossil fuels for energy and material production. Estimates of future woody biomass demands vary in the Shared Socioeconomic Pathways (SSPs), depending on societal development trends, climate model projections, socioeconomic conditions, and climate and energy policies. The SSPs are qualitatively and quantitatively defined at global and macro-regional level, and their implementation for individual sectors at a national basis is challenging. In this paper, we provide a modeling framework to translate key drivers of the SSPs to estimate future developments in an individual sector of a country, which is estimating future wood outtakes until 2100 from the Norwegian forestry sector. We use key drivers from the SSPs such as population and Gross Domestic Product (GDP) and specific aspects of developments in the land use sector. First, we analyze historical wood harvest trends from 1960 to 2016 for the main tree species and wood classes and construct a regression model based on population, GDP and time. The model is then adapted and modified according to an interpretation of the salient characteristics of the different SSP scenarios for a developed country such as Norway to estimate future outtake volumes for each combination of tree species and wood class. The SSP characteristics implemented in the model framework are GDP and population, land-use change regulation, participation of the land-use sector to climate change mitigation, and starting year of international cooperation for climate change mitigation. This work is one of the first to undertake a systematic interpretation of the global qualitative SSP narratives in terms of detailed quantitative studies for a specific national sector. Outcomes of the analysis can serve as a common basis to study possible developments of the forestry sectors and their products at a country level and their link with the SSPs make them of simple interpretation. The approach presented in this paper is easy to interpret and to be controlled, as it relies upon a bunch of simple handles. In principle, it is suitable for being applied in other sectors and countries as well. The model framework definition is independent from the characteristics of the case study since the parameters used to incorporate the key drivers and specific aspects of developments in the land use sector of the SSPs can be adjusted on a case-specific basis. Similar approaches can help to establish a bridge between global scenarios and more narrowed analysis for individual sectors, so to reinforce the use of a consistent background setting in interdisciplinary research activities at the interface between climate systems, resources, and society, and across different spatial scales of analysis, from global to

national.

Keywords: Forestry, Bioenergy, SSP, Climate change mitigation, Regression models

1.5DS scenario of China's power sector by 2050

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Abstract:

Abatement of Greenhouse gas emissions is the top concern of global climate change policy. On November 4, 2016, the Paris Agreements took effect officially, with the global consensus to limit temperature rise within 2DS above pre-industrial level and striving for 1.5DS. To achieve the long-term temperature rise goal, global power sectors need an urgent transition of net-zero and even negative emissions by around 2050. In this paper, we explore the possible scenarios and pathways of China's power sector into 2050. The purpose is to examine the possible options such as renewable energies, carbon capture and storage (CSS), bioenergy and their combination and their potential contribution to zero or negative emissions. By setting two scenarios (1.5DS and 2DS), the future transition pathways of power sector are discussed in this paper. Whatever 1.5DS or 2DS scenario, we find that the emissions will peak at around 2020 but 1.5DS requires deeper emissions reduction after 2020 and -1.5 billion tons emissions by 2050 with huge challenge of unconventional biomass supply requirement. Additional challenges include the feasibility of large-scale deployment of CCS, the mass integration of intermittent renewable energy and the stranded assets risks of coal power. The paper concludes with policy implications on how to better implement the power system transition.

Keywords: CO_2 emissions, Power sector, Transition pathways, China

Environmental and economic comparison of diesel and battery electric delivery vans to inform city logistics fleet replacement strategies

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Abstract:

Poor air quality in urban areas and environmental concerns attributable to road transportation are growing and significant problems for governments. Many different options have been proposed to lower emissions, and a critical one is the use of battery electric vehicles (BEVs).

Since city-logistics accounts for about 25% of urban mobility emissions, we focus on battery electric and diesel delivery vans. The aim of this paper is to present a holistic view of the problem, comparing the environmental, social and economic impact of BEV and diesel delivery vans, providing useful insights to policy makers and fleet owners willing to replace or select delivery vans to include in their city-logistics fleets.

In cities where new BEV vans replace old diesel vans and the electricity mix is relatively clean, CO_2 emissions and air pollutants decrease by 93-98% and 85-99%, respectively. If BEVs use electricity coming from coal energy and are compared to new diesel vans, reductions of CO_2 emissions and air pollutants are in the order of 12-13% and 0-92%, respectively. Longer battery life and greater annual mileage improve these results and decrease cost differences. Results also reveal that annual emissions benefits of replacing older diesel vans with BEVs are on the same order of magnitude of equivalent annual cost differences.

From a strictly business perspective, BEV vans are already economically attractive in some cities with existing incentives; however, for other cities incentives equal to the value of their emissions reduction benefits are needed, but might not be sufficient to justify BEV acquisition.

Keywords: Commercial battery electric vehicle, Delivery vans, City logistics, Sustainable urban deliveries, Environmental LCA, Economic LCA

Integrated reverse logistics into green supply chain by EPR

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Abstract:

Increasing electronics producers have been trying to include the reverse logistics into their integrated green supply chain as a respond to the growing market and legislative requirement on extended producer responsibility. This research present two different strategies by brand producers in China in their efforts to build a sound circular economy along their supply chain: (1) involving the physical collection and recycling by the sales network; and (2) building strategic partnership with third party recyclers. Based on field work and firm interviews conducted in 2016 and 2017, we depict the relation between the reverse logistics and the value chain in each model regarding the business strategy and competitive advantage of the brand producer. The implication to the EPR legislation and public intervention is discussed in conclusion.

Keywords: Reverse logistic, Green supply chain, Extended producer responsibility, E-waste

An assessment of sustainability of non-fuel minerals resource extraction and utilization through a US copper case study

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Abstract:

The concept of "sustainable mining" has been examined and acted upon by the mining industry since the 1990s, with focus on reducing the environmental footprint of mining in terms of energy consumption, water consumption, waste production, and other metrics. Despite these efforts, mined materials continue to have an ever-increasing environmental footprint, as the amount of material mined has increased with population and economic growth; waste production has increased with the transition to open pit mining from underground mining; and energy, water, and reagent use have increased as ore grades continue to decline, resulting in more greenhouse gas emissions and also water and soil pollution. Development of a broader framework for sustainability that can be applied to mining is critical to ensure that as the demand for raw materials continues–driven by such increasing factors as population, urbanization, and GDP–there is an infrastructure to meet demand sustainably and responsibly with respect to environmental resources. This work will investigate approaches for meeting demand for non-fuel minerals–specifically using copper as a case study–in a more sustainable manner.

Copper is among the highest value metals mined in the U.S., second only to gold, but produced in quantities several orders of magnitude greater than gold. Thus, when considering the U.S. metal economy, copper is one of the most important commodities to quantify. Historical data pertaining to copper extraction, processing, manufacturing, use, and end of life are used to quantify existing stocks and flows of copper in the U.S. These stocks and flows can then be used to identify specific life cycle phases that either enable or limit the circularity of this material. The identification and inclusion of complete end of life data in this materials flow analysis contributes to the field because existing models primarily predict this value based on use phase lifetime, and do not include primary data.

The objective of the model development is to provide guidance and insight to increase the circularity of the copper life cycle. The modeling framework can be extended to be applicable to evaluate and improve the sustainability and circularity of other mineral resources.

Keywords: Mineral resources, Resource extraction, Resource utilization, Non-fuel minerals, Copper, Sustainability

Recycling of REEs and critical metals from WEEE scrap

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Abstract:

Metals are important for human civilisation. At present, more than 1.8 billion tons metals are produced annually in the world, including iron and steel (the large majority, ca. 95%), bulk non-ferrous metals (such as aluminium, copper, lead, zinc, nickel, cobalt), precious and platinum group metals (PGMs), and rare and rare earth metals. Recycling of metals can slow down the rapid consumption of primary resources, save large amount of energy and reduce significantly the emissions and environmental impact. Metals recycling has been playing an important role in total metal supply for steel and most of non-ferrous metals and PGMs. In recent years, various countries and regions in the world (Europe Union, USA, Japan, China, and United Nations) have defined many metals as critical based on their economic importance and supply risk. As a common strategy, many rare and rare earth metals are considered critical in short and long term. These include Rare earth elements (REEs), many scare metals, PGMs, and most of refractory metals. Critical raw materials supply will increasingly play an important role in all industrial sectors in the future. For example, most REEs are critical to many important applications. Primary production is limited by the availability of the natural resources of minerals and energy, and by the heavy environmental burdens. In contrast, abundant secondary resources are readily available but not yet efficiently utilised. In particular, the more strategic materials from different types of end-of-life (EoL) products in the high tech areas such as waste electrical and electronic equipment (WEEE, or e-waste) are not sufficiently recovered, due mainly to the low collection rate, less efficient physical separation and metallurgical refining technologies.

NdFeB magnets are important for many “green” technologies. Because of their superior magnetic properties, NdFeB magnets are in high demand for small and large motors and generators. In the NdFeB permanent magnets, a number of REEs are used: neodymium (Nd), praseodymium (Pr), dysprosium (Dy), gadolinium (Gd) and terbium (Tb). Large NdFeB magnets in electric/hybrid cars and wind turbines may be suitable for re-use or direct recycling. However, small NdFeB magnets used in large variety of consumer electronics are difficult to recover because of their strong binding to other components and often with complex coatings, and are normally mixed in ferrous scrap and is lost in steelmaking slags during recycling process. Until now, EoL NdFeB magnets are not yet recycled in practice.

In this presentation, recent research from author’s group (Metals Production, Refining and Recycling) at Delft University of Technology (TU Delft) will be introduced for: (1) REE recovery from magnet wastes in WEEE shredder product streams, (2) recovery of valuable metals (copper and precious metals) from ICT-waste shredder fines. Both

mechanical processing and metallurgical separation and refining are used to recover the rare earth and other valuable metals. It indicates that metallurgical recycling can provide efficient ways for metal recovery and refining, when the scrap is complex and cannot be directly re-melted and recycled easily back to their original quality.

Keywords: Critical metals, Rare earth elements (REEs), Waste electrical and electronic equipment (WEEE) recycling, Metallurgical recovery

Volatilization behavior and kinetics of sodium-containing fluoride mould flux

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Abstract:

The physicochemical properties of mould flux play a crucial role in continuous casting process. Industrial mould flux is usually based on the CaO-SiO_2-Al_2O_3 ternary system, with an addition of fluorides and sodium oxides to ensure good properties. Traditional physicochemical properties measurement of mould flux is generally carried out at high temperature through a long time. So volatilization of fluorides and sodium compounds will occur inevitably, which caused serious environmental issues and health problems. In order to reduce the evaporation of fluorine containing gases from slags, volatile degree and deviation mechanism must be detected. In this study, non-isothermal thermogravimetric analysis at different heating rates was used to establish volatilization kinetic model for sodium-containing fluoride mould flux, and chemical analysis and X-ray diffraction were combined to reveal the volatilization mechanism. The results show that NaF and SiF_4 are the decisive factors of evaporation from slags, and lead to composition change and properties deviation. The most probable evaporation kinetic mechanism function of volatile component for sodium-containing fluoride mould flux can be expressed by g(α)=[-ln(1-α)]^(2/3), with apparent activation energy of 164.866 $KJ\cdot mol^{-1}$ and pre-exponential factor of $2.13\times10^{-4}s^{-1}$. The reaction mechanism is random nucleation followed by growing, which is the limiting factors for volatilization of sodium-containing fluoride mould flux.

Keywords: Fluoride mould flux, Volatilization kinetics, Thermogravimetric analysis, Mechanism function

Study on vehicle routing optimization of hazardous waste transportation based on third-party logistics - A case study of Beijing

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Abstract:

Hazardous waste management is a global issue that has become a serious concern for societies during recent years. In China, the definition of hazardous waste is basically consistent with the international definition of hazardous waste, which refers to one or several hazardous characteristics such as corrosion, toxicity, flammability, reactivity or infectiousness or does not exclude hazardous properties that may have a detrimental effect on the environment or human health and that require the management of hazardous waste. From large industries to small businesses, hospitals, households, and other places are main sources of hazardous wastes. The biggest difference distinguishing the hazardous waste from the ordinary waste is its hazardous characteristic and various risks. Besides, with rapid progress in economy and technology, the output of hazardous wastes is increasing gradually all over the world as well as the rate of the hazardous waste generation. If the hazardous waste is not properly managed, it will endanger the human health and ecological environment, and even affect the sustainable development of the economy. Therefore, the design and optimization of hazardous waste management systems are of paramount important.

There are many stakeholders involved in the HWM system, and the reality of China's traffic and the output of hazardous waste can’t be ignored. Therefore, this paper studies the vehicle routing optimization of municipal hazardous waste transport. The problem considered in this paper tries to develop a new formulation of routing optimization in the case of municipal hazardous waste transport, which incorporates various types of hazardous wastes, vehicle with capacity restrictions and time windows, etc. And a multi-objective mixed integer linear programming model based on third-party logistics distribution was proposed, aims to reduce the harm to humans and environment during the process of hazardous waste transportation and the total cost of transportation companies. Transportation risk includes population risk and environmental risk simultaneously in the model.

The proposed routing planning problem in the paper is a large-scale multi-objective mixed integer linear programming model, and it’s belongs to group of NP-hard problems, which means that finding optimal solutions is generally difficult. Recently, the goal programming technique and linear weighting method have been widely used as the efficient conversion approaches to solve the multi-objective routing optimization problem of hazardous waste. As a consequence, we implement the weighted goal programming method firstly. Namely transforming our proposed multi-objective routing problem into a weighted single-objective one based on the goal

programming technique. According to the characteristics of the model proposed, the ant colony algorithm with high search efficiency and good robustness is selected here to find the optimal transportation path.

Finally, the article takes the medical waste transportation of tertiary hospitals in Beijing as an example to verify the examples and to clarify the method. In our paper, the research on the vehicles routing optimization of municipal hazardous waste transport will provide the basis for government policy makers and transport enterprises to formulate a scientific and effective collection and delivery routes.

Keywords: Hazardous waste, Third-party logistics, Vehicles routing optimization, Weighted goal programming method, Ant colony algorithm

Environmental risk assessment of chemical industry based on ERA-FEM

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Abstract:

Chemical industry is recognized as one of the main risk sources of sudden environmental pollution accidents, owing to the hazard characteristic of chemicals and complex process. Therefore, environmental risk assessment of chemical industry plants is of great significance to regional planning and risk prevention and control. In this study, an environment assessment index system was developed, in which includes five criteria layers with 25 indicators, such as quantities of hazardous chemicals, characteristic of production processes, waste discharge, surrounding environment, and measures used to prevent risks. Ten experts were invited to determine the weights of these indicators. Moreover, the method based on analytic hierarchy process and fuzzy evaluation model (ERA-FEM) was developed. Risk levels of ten chemical industry plants in China were assessed based on this method, and suggestions were proposed for control environmental risk in these industrial plants.

Keywords: Environmental risk assessment, Chemical industry, AHP, Fuzzy evaluation model, China

Life cycle assessment of cement production with carbon capture and storage technology

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Abstract:

Cement is one of the most abundantly produced materials and the production has been increasing steadily in the world. According to the model of International Energy Agency (IEA), the cement production will get to 3.69~4.40 billion tons by 2050. Cement industry is an energy and CO_2 intensive industry and it is the second biggest CO_2 emissions source, which contributes to around 5% of the global greenhouse gas emissions. Carbon capture and storage (CCS) is currently considered the most feasible new technology option to reduce CO_2 emissions in the cement industry. Many research works were implemented to improve the capture technology and lower the capture cost in the cement industry. However, many CO_2 capture studies on environmental aspect focused only on energy efficiency and reduction of CO_2 emissions. Some extra energy or energy penalty and other materials are needed to implement carbon capture, transportation and storage, which will lead to some environmental impacts except global warming from the perspective of life cycle assessment. Some studies have focused on the comprehensive environmental impacts of power plants with CCS, while only a few studies have involved in the cement industry. A systematic comparison of LCA-based environmental performances of the cement production in Europe for 2025 and 2050 with and without CCS was studied. A detailed life cycle assessment of applying CCS to the Spanish cement production was carried out. However, both these studies focused only on the post-combustion CO_2 capture, there is a lack of study on oxy-combustion CO_2 capture. According to the CO_2 emissions reduction target in the IEA roadmap, about 40% of global cement production capacity could be equipped with CCS during 2030-2050 period. So more researches on comprehensive environmental impacts are needed to provide the basis for the implementation of CCS in the cement industry.

This study aims to analyze and compare the comprehensive environmental impacts of cement production with/without CO_2 capture technologies, put forward some improvement suggestions. A typical modern European cement plant, whose production capacity was 1Mt/y of cement, was selected as a case study. The preferred technologies for capturing CO_2 in cement plants are post-combustion and oxy-combustion capture. The cement production process, carbon capture process, CO_2 transport process and CO_2 storage process were involved, and four scenarios were set up within the system boundary. The environmental impacts considered in this study include global warming, human toxicity, aquatic ecotoxicity, terrestrial

ecotoxicity, photochemical oxidation, acidification, and eutrophication. Results show that the implementation of CO_2 capture and storage can significantly reduce global warming. However, it can lead to an increase in some other environmental impacts. We must pay more attention to and try to reduce these environmental impacts before we advocate the large-scale implementation of CCS in the cement industry.

Keywords: Cement industry, Carbon capture and storage (CCS), Post-combustion, Oxy-combustion, Life cycle assessment (LCA)

Examining metal sustainability and its implications in China – A critical review

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Abstract:

In recent decades, anthropogenic activities have accelerated the deterioration of the environment and loss of natural resources. The main reason for increasing demand on natural resources is the continuation of unsustainable consumption patterns due to rapid population growth and industrial development. China as a global dominator of industrial wealth, it is much pressurized on physical resources such as metals because China is a major supplier of high-tech products which affects evidently for its economic prosperity. Therefore, this review addresses present status of metal industry, how to achieve sustainability using recycling processes and practices used in the promotion of effective mechanisms regarding to China. The study was conducted based on analyzing information obtained from secondary sources such as scientific literature and reports. China as the largest manufacturing producer of electrical equipment, much attended on the sustainability of metal industry to overcome future challenges due to resource depletion. Photovoltaic applications are mostly beneficial from metal industry in China. Therefore, decreasing potential of metals will be highly impacted for energy related industries, which will be eventually disadvantageous for economic growth of the country. As a topical solution for that, recycling capacity of disposable electronic and electrical materials should be encouraged from ground level to sustain the industrial requirements. On the other hand, recycling technology towards a high efficiency should be developed to respond the coming huge scale obsolesce of metals. So that, urban mining for metal resource supply should play an important role in sustainability of the industry. Furthermore, it should be required to strengthen the domestic policies related to industry for its future sustainability. Besides that, it is needed to improve assistance and incentives to encourage the recycling of metal trash to build up economic motivation.

Keywords: Anthropogenic activities, Resource depletion, Metal industry, Urban mining, Sustainability

Life cycle inventory of underground mining of bauxite: A case from Bespelj mine in Bosna and Herzegovina

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Abstract:

Life cycle analyses of the metals require original mining data that can be related to the ore type and quality, type of ore body, its surrounding (geology, hydrology, topography), mining method, technology, and significance to the local community. Original mining data are difficult to obtain and there are uncertainties related to data reliability. Ideally, the inventory should be transparent, open and enable the modelling.

The objective of this research is to give the life cycle inventory for underground bauxite mining. The inventory is based on realistic data collected during the three years of mining in Bešpelj Mine near Jajce. Time scale analysis and statistical analysis of data enable the modelling of the inventory for different outputs of ore. Additionally, the inventory from this research can be used for the LCAs of underground mining in similar production circumstances.

Geological exploration of bauxites in the area of Jajce is started in 1955. and yielded many interesting geological findings on underground bauxite deposits. Bauxite ore bodies in Bešpelj, as other numerous sedimentary bauxite ore bodies in the area of Jajce, originated during the emersion phase of the long-lasting Cretaceous marine carbonate sedimentation, now known as area of the Internal Dinarides. These bauxites occur within the shallow-marine succession of carbonate rocks (limestones and carbonate clastics), which are present in the footwall and the hanging-wall of the ore bodies. In the footwall, karstified Middle Cretaceous limestones predominate, while in the hanging-wall carbonate breccias and calcarenites alternate.

The underground system of Bešpelj is tectonically complicated. The terrain is well developed, between river canyons (as low as 310 m) and mountains heights (above 1400 m). The climate is moderate continental with abundant winter precipitation. Average summer temperature is 20C, and the winter extremes go below -20C. The underground abundant in water communicates well with rivers Vrbas, Pliva, Ugar and various creeks. The surface of Bešpelj area is covered with pine forest and grassland (pastures) and is poorly populated. The roads are connecting well the mines with town and other populated places.

The bauxites of Jajce area are boehmite deposits of excellent quality, well explored, high in aluminum oxide and low in silica content. The production in Bešpelj is ongoing since 1958 (except interruption during 1991-2005 due to war and its consequences).

The method of mining is sublevel caving, both, with leaving of the empty spaces and with collapsing of the caved space. The extraction method is drilling and blasting, load and haul with pneumatic engine load shovel. Underground transport includes trolley-cart, gravity transport, and DC (battery) rail transport to the surface where the ore is gravitationally loaded into the trucks. The mine is supplied with compressed air (for the load shovel and pneumatic drill/hammer) from compressor station at the surface and underground compressor tanks. For the transport of miners from Jajce town the bus and shuttle transport is used. The mining company is well integrated in society, contributing to social and economic development of the area.

Keywords: LCI, LCA, Underground mining, Bauxite, Environmental impact assessment

Mineral sequestration of CO_2 with brine in tubular reactor

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Abstract:

CO_2 mineralization is an effective process to sequester CO_2 into solid carbonates permanently. A source of alkaline earth metals for CO_2 mineralization that has not received as much attention, but which can have significant sequestration capacity based on worldwide availability, are desalination brines. This is a kind of concentrated seawater containing sodium, magnesium, calcium, chloride, iron, among other ions, for which there is no present use. In this work, we propose to investigate the brine carbonation process with a continuous plug-flow tubular reactor. This is reaction system is particularly suitable for industrial applications given its ability to be easily scaled-up, and enabling better process control, optimization and integration.

In order to obtain saturation and precipitation of carbonates in this reaction system, it is necessary to control the pH value, as the continuous injection of CO_2 into the system leads to solution acidification. The approach used in this research to counter this effect was to contact the brine with blast furnace slag, to transfer alkalinity to the brine and to concurrently offer extra mineral ions in the solution; sodium hydroxide solution was used as an additional alkali substance to study the effect of pH on the carbonation conversion. The effect of reactor temperature, CO_2 gas and brine flow rates (and flow rate ratios), and brine concentration were also studied. In each experiment, the concentration of ions in the inlet and outlet streams was determined by ICP-OES, pH and conductivity of the streams was recorded, solids products were collected for further analyses, and the void fraction of the three-phase slug flow was determined by image analysis of recorded video of the flow pattern.

The results show that Calcium Conversion Efficiency (CCE) reaches the highest value, at a given brine feed flow rate, when the flow rate of CO_2 is enough to supply the reaction without over-acidifying the solution Any higher or lower flow rate leads to lower CCE. By adjusting control variables to the optimum combination, CCE can reach up to 100%. The optimum point of reactor operation is also characterized by having the lowest outlet conductivity, as fewer ions remain in solution, and a pH that is transitioning from alkaline to neutral (i.e. between 10 and 7). The use of slag as a buffering agent contributes to higher CCE over a wider range of process conditions.

The presence of sodium and magnesium ions in the brine, in the form of chlorides, slightly reduces the CCE, and affects the crystallography and morphology of the

formed particles, as characterized by FTIR, XRD, TGA and SEM. Spherical and rhombic (i.e. calcitic) particles were formed at 25°C, whereas needle-like (i.e. aragonitic) particles were mostly formed at 50°C. The results demonstrate that the proposed process with tubular reactor is a promising technology for CO_2 mineralization and for utilization of desalination brine and slag.

Keywords: CO_2 sequestration, Desalination brine, Calcium carbonate, Tubular reactor, pH buffering, Three-phase slug flow

Cost of MSW services accounting in Beijing under the integration of the two networks

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Abstract:

With the development of urbanization and the improvement of people's living standard, the quantity of municipal solid waste (MSW) in China is increasing rapidly. Beijing with developed economy and large population density, its quantity of municipal solid waste (MSW) increased from 6.344 million tons in 2011 to 8.772 million tons in 2016. The MSW services in China is still entirely responsible for the government. Based on the current charging policy, the minuscule earning is insufficient to cover the cost causing a huge financial pressure.

The government is actively adopting ways to reduce the MSW services cost recently. The waste disposal network and renewable resource recovery network in China now are still two independent operation systems and the policies like the forced classification of refuse promulgate to promote the integration of the two networks which is the trend of MSW management pattern in China. Therefore, this study will take into account the background of the integration of two networks. On this basis, changing the charging mechanism to relieve the municipal finance pressure is another problem. Therefore, scientific cost accounting for MSW services as a basis shows its necessity.

Since the main way of waste disposal in China is still sanitary landfill, this study only considers the social cost in the case of landfill. Taking Beijing as an example, this study calculates the social cost of MSW services with two networks integration. Firstly, the study constructs a basic framework of full cost accounting (FCA) which determines the boundary of cost elements, and divides the cost elements into three parts: collection cost, transportation cost and processing cost according to the life cycle of MSW services so as to develop cost function. On this basis, taking into account the integration of the two networks, the resulting changes in cost mainly include the following three points: (1) Due to the reduction of refuse disposal caused by recycling, the social cost thereby reduces; (2) The economic value of the recyclables covers part of the social cost; (3) Collecting and processing recyclables brings some cost. Then the study evaluates the cost with extending the FCA framework which takes the above three points into account and compares with the basic cost.

The study found that with the two networks integration, the social cost of MSW services will be greatly reduced, especially in the transportation and processing parts, which can prolong the service life of the sanitary landfill. For Beijing, this means that it can bring huge economic value and potential environmental benefits. The research's cost accounting method is universal which has reference value for

other large cities. Based on the result of the research, the government should formulate a scientific and transparent cost accounting system, and regularly public accounting cost. On one hand, it can guide the public to form a correct understanding for social cost so as to cultivate a sense of waste classification and promote the integration of the two networks. On the other hand, it can provide a scientific charging basis for charging mechanism according to emissions.

Keywords: Municipal solid waste services, Social cost, Full cost accounting, The integration of the two networks

The multi-transfer station municipal solid waste collection and transportation network under demand uncertainty

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Abstract:

Municipal solid waste, as an inevitable result of urban activities, is a widespread concern in modern society. With the continuous population growth and the continuous improvement of people's living standard, the growing negative impact on society, economy and environment is caused by the increasing amount of municipal solid waste(MSW) generated. Therefore, it is necessary to establish a sustainable and efficient waste management system. Waste collection and transportation system is one of the important components with high cost and many uncertainties. The amount of waste produced by residents varies with season alternation, government policy change and the public awareness of environment problem. These perturbations may make the solution achieved by determined model less attractive, even infeasible. Therefore, we need to focus on the optimization of the waste collection and transportation system.

This paper researches on the MSW transportation routing optimization problem, studying the two-echelon network model of MSW collection and transportation, which consists of collection center (waste chamber) and transfer station, while multiple transfer stations, vehicle capacity, routes capacity, multiple vehicle parade and other constraints are considered. If the vehicle capacity is larger than the route's volume capacity, there will be only one transfer station trip and it will be the last visit before returning to the depot. If, however, the route's volume capacity is more than vehicle capacity, multiple transfer station trips will be needed in a route. Since there are multiple transfer stations available, careful selection of the best trip is critical. In addition, combining with the actual waste collection and transportation network, the paper takes into consideration the uncertain demand of the collection center to form a more robust vehicle path. Finally, this paper proposes a robust model of MSW collection and transportation network with multiple transfer stations and uncertain demand, which aims to minimize the transportation costs and the number of vehicles.

The proposed routing programming in the paper is an uncertain optimization problem. Robust optimization has been remarkable by many researchers as a new method for dealing with uncertain problems. The robust optimization model fully takes into account the parameter uncertainties, making sure of constraints satisfaction on the realization of all the parameters those make values in the given uncertain set, and there is no requirement for the parameter to obey the probability distributing. In this paper, according to the framework of Bertsimas robust optimization, a robust optimization model considering the demand uncertainty of the collection center is first established and transformed into a robust corresponding

model, which transforms the initial uncertain problem into computable tractable certainty mixed integer programming problem. Finally, the article takes the MSW transportation network in Beijing as an example, finding the robust collection and transportation path scheme to adapt to the demand change by using the heuristic algorithm. The results show that robust optimization can help decision makers find a more robust anti-interference solution.

Keywords: Municipal solid waste, Collection and transportation network, Demand uncertainty, Robust optimization, Heuristic algorithm

Sailing towards a circular economy: Potential for increased reuse and remanufacturing of ship components

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Abstract:

The transition to a Circular Economy (CE) requires enabling conditions that remove existing barriers in product use and material recovery operations. This contribution reviews literature on material resource efficiency within the context of the European Union (EU), specifically in the shipbuilding and maintenance sector, and discusses how appropriate business models and policies can enable increased reuse and remanufacturing. The adoption of new business models is of key importance in CE, but their viability often depends on supporting policies.

Recycling in the maritime industry is a widespread practice due to the valuable material content of ships at their end of life. Approximately 95–98 % of ship materials by weight are recycled. However, ship demolition is usually associated with poor health and safety conditions for workers and adverse effects on the environment where the process takes place, most commonly in South Asian dismantling yards on coastal areas (also known as beaching). Furthermore, following CE principles, recycling is not considered as the most favourable option for end of life products. As outlined in the recent CE Action Plan (COM (2015) 614 final), operations such as reuse, repair, and remanufacturing do not only contribute to material resources savings, but also value savings in the form a labour and energy.

Such operations can be used to prolong the lifetime of marine structures and drastically delay the inevitable stage of recycling. Yet, remanufacturing rates in the marine sector are low compared to other sectors, such as aviation and automotive. Therefore, to identify the reasons behind this low remanufacturing rate and potential opportunities within Europe, this paper investigates two case studies of stakeholders specialising in construction and repair of ships and yachts in Sweden. Based on an analysis of literature and the companies' business model barriers, the findings of the case studies enhance and complement existing knowledge on support measures for increasing circularity in reuse and remanufacturing business models.

Initial results indicate companies favour eco-design and durability criteria for new ships and propose that a gradual introduction of extended product warranties would favour the repair and maintenance of ship components. Economic instruments, such as tax cuts or subsidies on reused or remanufactured components were positively viewed by the companies. However, uncertainty regarding timing and quantity of returned cores is a significant barrier to undertaking circular strategies. Additionally, the small quantity of products collected from each ship makes it difficult to achieve economy of scale. Looking forward, given the long lifetime of ships, it is essential to

encourage design improvements and circular business models through appropriate policy instruments, aiming to reduce environmental impacts and increase the durability and recyclability of their components.

Keywords: Circular economy, Remanufacturing, Marine remanufacturing

A comparison of public risk perception, exposure level and WTP/WTA of PM2.5 during the Youth Olympics

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Abstract:

Haze pollution accompanied by high concentrations of particulate matter especially PM2.5 in the atmosphere have attracted increasing attention recently because of their adverse impacts on the ecological environment and public health. Authoritative short-term emission control measures have often been implemented to improve air quality during important sporting events in China. As a condition for hosting the 2014 YOG, the local government agreed to temporarily and substantially improve air quality in Nanjing for the YOG. Regression analysis, Spearman correlation analysis, chi-square test, and the Contingent Valuation method were used to explore the effects of powerful short-term air pollution control measurements on public psychological perceptions, daily exposure of PM2.5, risk acceptable levels and WTA/WTP. Three surveys were conducted in Nanjing before, during and after YOG, respectively. Great differences of risk perception, daily exposure, risk acceptable level, and WTP/WTA in three periods were revealed. The Respondents had the highest level of PM2.5 exposures before YOG, and the lowest level during YOG. After YOG, the respondents' daily exposure level increased but still lower than that before YOG. Residents' risk perception level presents the following changes: during YOG, the respondents perceived the lowest effects of haze pollution while after YOG, they perceived the highest effects. The changes of risk acceptable level showed the same the tendency, which demonstrated that people were more sensitive to PM2.5 concentrations and claimed higher requirements for air quality after the government powerful emission control measures in the period of YOG. Meanwhile, respondents' willingness to pay for risk reduction and protective measures increased during YOG and achieved the highest after YOG. Before YOG, residents' willingness to accept compensation was higher than that during YOG. However, after YOG, residents asked for the most economic compensation after they experiencing the good air quality during the YOG, residents realized that the government was responsible for the air quality improvement and has capability to take measures to reduce public health risk from air pollution. Besides, women, young people aged 20-39 and residents with lower income or lower education level exposed to higher level of PM2.5 concentrations. The government should take priority attention to the above-mentioned sensitive groups and take long-term and effective measures to meet the residents' higher requirements for air quality after YOG.

Keywords: Air quality, Risk perception, PM2.5 exposure, Youth Olympic Games

Geospatial characterization of material stock in the residential sector of a Latin-American city

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Abstract:

Urban systems gather an enormous repository of materials and are a potential source of primary resources in the future. In contrast with other regions (e.g. Europe), insufficient research has been conducted on this topic in Latin America. Thus, this presentation will describe the application of a methodological approach used to analyze the material stock (MS), and its spatial distribution, in the residential sector of a young Latin-American city: Chiclayo in Peru. A combination of GIS data, national census information and data collected from different sources (e.g. field studies and google street view) were used to yield specific indicators for the physical size of buildings (i.e. gross floor area and number of stories) and their material composition. Results shows that in 2007 the overall MS in buildings was estimated at 24.4 million tonnes (Mt) or 47 tonnes per capita. This mass is primarily composed of mineral materials, mainly concrete (14.1 Mt), while organic materials (e.g. 0.15 Mt of wood) and metals (e.g. 0.40 Mt of steel) constitute a minor share. Also, approximately two-thirds of the overall MS is contained in the upper components, while the remaining is embedded in the foundations. Moreover, the geospatial accumulation of the main construction materials across the city was developed and analyzed. The central core of the city had a major presence of concrete and clay brick, while the adobe was more concentrated in the peripheral area. In addition, historical census data and projections were also used to evaluate the changes in the MS from 1981 to 2017; showing a significance increase (around 360%) in the last 36 years. Finally, when comparing the results with other case studies significant variations were found. For example, MS per capita in Vienna is three times larger than in Chiclayo. An important contribution of this study is the feasibility of implementing this methodology in cities with scarce or low-quality data, as is the case of some developing countries. Moreover, the findings of this study provides essential supporting information for different stakeholders, such as urban planners, as it characterizes and quantifies the resources contained in urban systems and its future potential for the reverse supply chain of materials. Also, results are an important input for the development of waste management strategies related to demolition activities or from natural disasters (e.g. earthquakes).

Keywords: Geographical information systems, Industrial ecology, Material intensity, Resource recovery, Urban environment, Urban stocks

Optimization of collection and transportation route of municipal solid waste considering carbon emissions

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Abstract:

With the acceleration of urbanization, the continuous improvement of living standards has led to a rapid increase in the number of consumer goods. The amount of municipal solid waste (MSW) generated has rapidly increased, and the existing municipal solid waste management system (MSWM) is facing severe challenges. Therefore, it is urgent to reform and perfect the existing system. Recently, the relevant departments issued the Implementation Plan for Domestic Waste Classification System, prompting the integration and development of the two networks of urban sanitation and renewable resources systems, achieve waste reduction and recycling.

MSWM includes the collection and transportation of the waste front end and the disposal process of the back end. The front end refers to the collection and transportation of MSW from the production site to the collection centers, sorting centers, transit centers and other places, which are the intermediate links connecting the generate source and processing facilities. Disposal of MSW is based on the composition and quantity of different, the scientific choice of landfill, incineration, composting and other treatment methods, to reduce the amount of waste and pollution levels. Cost is an important factor affecting the management of municipal solid waste, and the cost of collection and transportation accounts for a large proportion of the total waste management budget (sometimes more than 75%). Therefore, the paper focuses on the front-end collection and transportation process, to study the waste collection / transportation routes network optimization, and achieve the goal of minimizing costs.

With the acceleration of economic development, the sharp increase in energy consumption, carbon dioxide emissions are also more and more. Research shows that exhaust emissions from vehicle transport are a significant source of carbon emissions. In the process of collection and transportation of MSW, a large amount of fuel is consumed and the released carbon dioxide has a negative impact on environment. Therefore, minimizing fuel consumption during the front process can result in fuel savings and environmental benefits. So, this paper considers the impact of carbon emissions on the optimization of waste collection and transportation routes, and explores the impact of distance, vehicle speed, load, congestion conditions and road gradient on fuel consumption rate, and then characterizes the fuel consumption under different path selection and its carbon emission level.

In order to optimize the collection and transportation of MSW considering the carbon emission, a multi-objective optimization model with the goal of minimizing the total

cost and the carbon emission is established. Consider the cost impact of fixed costs and transportation costs on cost targets; consider the impact of distance, vehicle speed, and load and traffic conditions in the carbon emission targets. Compared with Genetic Algorithm, Ant Colony Algorithm, Simulated Annealing Algorithm, etc., we choose a heuristic algorithm with high robustness and high searching efficiency to solve this problem.

Finally, taking Chaoyang District, Beijing as a case, the validity of the model is verified. Under the goal of minimum cost and minimum carbon emission, determine transport options, establish a low-carbon transport network, and optimize cost-effectiveness and environmental impact.

Keywords: Municipal solid waste, Carbon emissions, Route optimization, Multi-objective optimization model, Heuristic algorithm

Model-based synthesis and Monte Carlo simulation of biochar-based carbon management networks

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Abstract:

Biochar-based carbon management networks (CMNs) can achieve negative rates of greenhouse gas (GHG) emissions by storing carbon fixed from the air in a stable form in soil. CMNs can be optimized in the same manner as reverse supply chains using mathematical programming models, and in particular, mixed integer linear programs (MILPs) are often used as computationally efficient formulations. Integer-cut constraints in MILP models can be used to generate optimal and near-optimal solutions, and Monte Carlo simulation can then be used to gauge the performance of these CMNs. This three-step procedure can then be applied to assess the robustness of CMNs amidst variations in biochar supply due to various factors that may arise such as changes in agricultural productivity due to climate change induced events. An illustrative case study is explored using the methodology developed. This work provides a rational basis to aid the efficient planning of biochar-based CMNs.

Keywords: Biochar-based carbon management networks, Carbon sequestration, Mixed-integer linear programming, Integer-cut constraints

Energy benefits of electrified autonomous vehicles (EAVs): Estimated from a physics-based model

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Abstract:

Autonomous vehicles (AVs) are a disruptive technology likely to revolutionize future mobility. Using sensors and computers to replace human drivers, AVs offer mobility for those unable to drive, e.g., elderly and young. AVs may facilitate shared mobility, which implies a decrease in car ownership. Large-scale adoption of AVs is likely to have profound societal, economic, and environmental impacts.

A number of recent studies have evaluated the ranges of potential fuel consumption changes associated with large-scale AV deployment based on AV features affecting vehicle miles traveled (VMT) and vehicle efficiency. Literature studies predict that easier travel with AVs will be the most influential feature potentially increasing VMT by 20%-160% while other features such as less hunting for parking, new user groups, ridesharing, and empty miles are expected to change VMT by -12%-40%. Among efficiency related AV features, researchers estimate vehicle right-sizing can save 0%-50% of fuel use while other features including platooning, collision avoidance, communication between vehicle and infrastructure, drive smoothing, and faster travel are estimated to have smaller impact (Stephens et al. 2016). However, these fuel use savings apply to only AVs with internal combustion engine (ICAVs). Although the market for electrified vehicles (EVs) such as battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs) is growing rapidly, there are few studies of the energy savings of electrified AVs (EAVs).

We evaluate the energy savings of EAVs compared with the known fuel savings of ICAVs based on a physics model developed at Ford. We focus on the vehicle efficiency features of AVs such as right sizing, platooning, drive smoothing and faster driving since changes in VMT will be the same between ICAVs and EAVs. Our model breaks down fuel use into contributions which are mass-dependent (to overcome rolling and acceleration resistance) and mass-independent (to overcome aerodynamic resistance and meet auxiliary power demand). The model incorporates powertrain efficiency (for the engine and motor), energy savings in the regenerative braking, and different driving cycles.

First, we establish the correlation between AV features and vehicle resistances. For example, platooning will reduce aerodynamic resistance while drive smoothing will reduce acceleration resistance. In addition, if vehicle size is reduced, both mass-dependent (rolling and acceleration) and mass-independent (aerodynamic) resistance will be reduced. Second, we estimate the fuel changes from these resistance changes by accounting for the efficiency of the EAV powertrain compared with the ICAV powertrain including energy savings from regenerative braking. We

modify drive cycles to simulate drive smoothing and faster driving to measure energy savings from these AV features. Finally, we conduct uncertainty analyses to provide energy saving ranges depending on factors such as EAV powertrain efficiency and battery size.

Keywords: Transportation, Autonomous vehicle, Electrified vehicle, Battery electric vehicle, Fuel efficiency, Driving cycle, Energy saving

Relationship of air pollution and urban development in the United States

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Abstract:

Air pollution is a widely concerned issue in the U.S., and multiple air pollutants may have both separate and synergic effects on environment and human health. Rapid development and urbanization have caused many environmental problems. The emission of air pollutants in cities are partially driven by production and consumption decisions such as the economic composition, residential activities and transportations. However, the relationship of urban development with air quality has not been unveiled clearly. This study aims to correlate different urbanization indexes with several air pollutants including ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide and fine particulate matter (PM2.5). A set of over 470 cities and city groups in the U.S. was developed with population information and economical urbanization details including city shape, compactness, capital and transportation. Air monitoring stations were selected in certain radius of cities and cities groups and hourly air pollution monitoring data were obtained to investigate the correlations between urbanization indexes and air pollutant concentrations. The effects of population increase, rapid industrialization, increased number of motor vehicles and quick developed economics will be investigated.

Keywords: Urban development, Air quality, Urbanization index

Hydrothermal conversion of neutral sulfite semi-chemical red liquor into hydrochar

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Abstract:

Hydrochar was produced from neutral sulfite semi-chemical (NSSC) red liquor as a possible bio-based solid fuel for use in power generation facilities. Hydrothermal conversion (HTC) experiments were conducted using a fixed liquor-to-water volume ratio of 1:8 and reaction time of 3 h. Solutions were processed using different chemical additives, pH and temperature conditions to determine the optimum conditions required for producing a high energy content solid fuel. The hydrochar samples produced were analyzed by ultimate, thermogravimetric (TGA) and Fourier transform infrared spectroscopy (FTIR) analyses to determine physicochemical properties that are important for utilization as a fuel. The residual process liquids were also analyzed to better understand the effect of HTC process conditions on their properties.

It was determined that the optimum conditions for producing a solid fuel was at a reaction temperature of 250 °C, in the presence of acetic acid at pH 3. The maximum energy content (HHV) of the hydrochar produced from red liquor at this condition was 29.87 MJ/kg, and its ash content was 1.12 wt.%. This result reflects the effect of increasing reaction temperature on the physicochemical characteristics of the hydrochar. The increase of HTC temperature significantly reduces the ash content of the hydrochar, leads to a significant increase in the carbon content of the hydrochar, and a reduction in both the oxygen and hydrogen content. These effects suggest an increase in the degree of condensation of the hydrochar products, and consequently the formation of a high energy content material. Based on TGA and FTIR analyses, hydrochars prepared at high HTC temperature showed lower adsorbed moisture, hemicellulose and cellulose contents, with enrichment in content of higher temperature volatiles, such as lignin. Addition of acetic acid, and the resulting reaction medium pH reduction, had the next most significant effect. The liquid by-product is the sink for undesired inorganic elements and degraded organics.

Based on the results of this study, it can be stated that, under well optimized conditions, it is possible to produce a fuel from NSSC red liquor that can potentially be used in at least partial substitution of coal in power generation facilities.

Keywords: Red liquor, Hydrothermal conversion, Hydrochar, Higher heating value, Ash content, Thermogravimetric analysis

Scenario-based analysis on the energies structure induced carbon emission changes in China

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Abstract:

Global Climate Change is of vital importance to the develop of the whole world, while according to IPCC AR5, over 90% of possibilities of are attributed to greenhouse gases. Under the circumstance of increasing global warming in China, understand the structure of fossil energies is necessary and meaningful. In this study, we choose China as case study area and explore the possible energies structure change based on Scenarios Generator, then we analysis the different CO_2 emission under different scenarios. At last, we figure out the suitable scenario for future development in China. Through this paper, we could provide Scenarios Generator for future carbon emission to adapt climate change.

Keywords: Energies structure, Carbon emission, Scenarios generator

Design and optimization of urban reclaimed wastewater reuse network based on mathematical programming

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Abstract:

With the increase of population, the acceleration of urbanization process and the advancement of industrialization, the contradiction between supply and demand of urban water resources become increasingly prominent. The regeneration and utilization of urban sewage can replace a large amount of clean water resources, which is an effective measure to alleviate the shortage of urban water resources. Urban reclaimed wastewater mainly can be reused for agricultural irrigation, urban miscellaneous, industrial production and landscape environment. This paper studied the characteristics of different users of the reclaimed wastewater, and constructed the physical flow structure model of reclaimed wastewater reuse network, which was then simplified. And the mathematical model was established based on the simplified physical flow structure model, which chose reclaimed wastewater treatment capacity, reclaimed wastewater reuse capacity and main contaminants concentrations as key variables, and took the water balance of reclaimed wastewater reuse network and the limiting contaminants concentration of each users of the reclaimed wastewater as the main constraints. The objective of mathematical model was to get the minimum reclaimed wastewater treatment cost. The reclaimed wastewater reuse network after optimization can treat and reuse reclaimed wastewater according to water quality requirements of different users. The novel optimization method was then applied to a sewage treatment plant in China, which could demonstrate the applicability and effectiveness of the proposed method. Through the adjustment of the reclaimed wastewater reuse network, it was demonstrated 601,060 ¥ per day could be saved.

Keywords: Reclaimed wastewater, Mathematical programming optimization, Wastewater reuse

Wind energy resource performance evaluation of wind farms using fuzzy BWM-TOPSIS method

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Abstract:

Wind energy resource performance is of vital importance for the stable operation and sustainable development of wind farm. The accurate evaluation on wind energy resource performance of wind farm can probe into the flexibility of wind energy resource used as the raw material of wind power generation, which can provide references for resource management and healthy development of wind farm. A multi-criteria decision-making (MCDM) framework for wind energy resource performance evaluation was proposed in this paper, namely fuzzy BWM-TOPSIS method. Firstly, an evaluation criteria system for wind energy resource performance was developed based on related academic literatures and expert panel, which consists of five criteria, namely 'average wind power density', 'effective wind speed hours', 'change rate of wind power output', 'equivalent utilization hours', and 'wind curtailment rate'. Secondly, the fuzzy best worst method (BWM) proposed by Sen Guo in 2017 was employed to determine the weights of criteria, which can consider the vagueness of decision data and ambiguity of decision-maker. Meanwhile, the technique for order preference by similarity to an ideal solution (TOPSIS) method developed by Hwang and Yoon in 1981 was adopted to rank the wind energy resource performances of wind farms. Thirdly, an illustrative case including four wind farms (represented as WF1, WF2, WF3, and WF4) located in northern China was studied by using the proposed fuzzy BWM-TOPSIS method, and the result indicates WF3 obtains the best wind energy resource performance, followed by WF1, WF2, and WF4. Meanwhile, the criterion 'change rate of wind power output' holds the maximum weight (0.38). Lastly, to verity the robustness of the obtained result, a sensitivity analysis was carried out to analyze the effects of criteria weights on wind energy resource performance ranking of four wind farms, and the result shows WF3 always obtain the best wind energy resource performance. This study is conductive to wind energy resource management and operation improvement of wind farm, and the proposed framework can also be employed for other resource performance evaluation, such as solar energy.

Keywords: Wind energy resource performance evaluation, Wind farm, Fuzzy BWM, TOPSIS method, Sensitivity analysis

Energy conservation and CO_2 emissions reduction in polygeneration process of steel-chemical-construction industries

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Abstract:

Resource and sustainability challenges have been a serious problem attracted attention both domestically and internationally. Iron and steel industry (ISI), Chemical industry (CHI) and Construction material industry (CMI) are important industries in China as higher material consumption, energy consumption and air pollution emissions. Great transitions have occurred in the three industries, including material recycle, energy transition, and efficiency improvement, changes in production and demand structures. In this study, an integrated framework of inter-sector analysis is established for energy conservation and CO_2 emissions, and energy/material recycle flows are discussed. The results show that the internal efficiency improvement are crucial factors curbing the rising CO_2 emissions and energy consumption in these three sectors, and material and energy recycle are the effective measures for energy saving and CO_2 emissions. The results also indicate that energy consumption and CO_2 emissions will gradually decline under the synergistic effect of technology promotion and polygeneration process of steel-chemical-construction industries.

Keywords: Iron and steel industry, Sustainable development, Polygeneration process, Energy conservation, CO_2 emission

Allocation of carbon dioxide emission permits based on an economy-energy-environment perspective: A case study of Guangdong Province

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Abstract:

To mitigating environmental deterioration, emission trading scheme (ETS) is regarded as an efficient policy tool while carbon dioxide emission permits are the main trading goods in the ETS. However, the allocation of initial carbon dioxide emission permits from an energy-environment-economy (3E) perspective is not well researched. Although some literatures have studied other air pollutants by constructing a multi-objective programming model from the perspective of 3E, all the objectives in their models belong to the salient success aspiration level (SSAL) that needs to get as close as possible to the aspiration level, while the objective of survival aspiration level (SAL) that needs to move away from the aspiration level lacks of consideration. By proposing a SSAL-SAL programming model to allocate the initial carbon dioxide emission permits, this paper selects three proxies of abatement costs, energy efficiency and emissions as the objective function of economy, energy and environment respectively. Specifically, the first proxy belongs to the SSAL while the last two proxies belong to the SAL. Since the SAL problem could not be directly addressed by current goal programming (GP), this paper adopts a new method to solve the above SSAL-SAL programming model. To show the superiority of the proposed model, this paper compares the allocation result by proposed model with the result by grandfathering method which is a mainstream allocation method in practice. The empirical results of Guangdong Province show that the proposed model can not only realize low-cost emission reduction, but also can improve energy efficiency and reduce the negative impact on the environment, so as to achieve the coordinated development of the 3E system. Indeed, it is necessary for policy makers to allocate the initial carbon dioxide permits from a comprehensive perspective based on 3E perspective, instead of purely considering a single goal. This paper contributes to filling existing research gap and provides some useful implications for policy makers to adjust the current abatement policy.

Keywords: Carbon dioxide emission permits, Energy-economy-environment system, Multi-objective programming model

The dynamic equilibrium mechanism of regional lithium flow in the case of transport electrification

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Abstract:

Lithium is recognized as the key element of power battery, of which resource security and utilization efficiency is highly relevant to the sustainability of transport electrification. To assess the changes in lithium supply chain responded to the development of electric vehicle industry and corresponding impact, this study established a regional dynamic model of lithium stock and flow throughout the technical life cycle for China from 2000 to 2050. Based on historical data and well-designed data treatment techniques, this model provides output data about production, consumption and international trade of lithium content in types of commodities, lithium in-use stock and scrap lithium for 27 scenarios. The results indicate that the amount of lithium flow will be dozens of times larger than it is in 2000. Rising inflection point of annual domestic lithium minerals extraction curve will be reached by the year of 2030. With respect to the in-use stock, lithium applied in electric vehicles will account for the largest proportion since 2023, replacing lithium content in ceramics and glass. Comparing all types of lithium-containing commodities, import dependence of minerals will keep the highest within the temporal boundaries reflecting a non-negligible risk for supply-demand balance. Setting up domestic lithium reserve and cutting overcapacity of downstream commodities may be an option to reduce the risk. Lithium embodied in battery applications, especially in transport sector, represent the highest potential for secondary recovery. Establishment of an integrated lithium-containing battery recycling system both on the enterprise side and consumer side is essential.

Keywords: Lithium, Electric vehicle, System dynamics, Supply chain, Dynamics material flow analysis, China

Circular economy and behaviour change: Using persuasive communication to encourage pro-circular behaviours towards the purchase of remanufactured refrigeration equipment

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Abstract:

A number of behavioural barriers are preventing the development of the Circular Economy. An appropriate Behaviour Change Intervention (BCI) could help to overcome them. This paper investigates how effective the use of tailored Persuasive Communication could be in encouraging the practice of Pro-Circular Behaviours including the purchase of remanufactured products, particularly Refrigerated Display Cabinets (RDCs).

RDCs are used to stock and display chilled, frozen food and beverages in retail grocery stores. The manufacture of RDCs is typified by the extensive use of materials and energy, meaning that the development of a Circular Economy in this sector is particularly important. The Circular Economy is an economic and industrial system in which resources are used for as long as possible, this typically involves businesses adopting a circular approach to the production and utilisation of products by implementing a range of alternative business models, such as remanufacture. There is scope for remanufacturing to support the more resource-efficient production of RDCs.

Currently remanufacturing rates in the UK Retail Refrigeration Industry are low. This is due to consumers in the industry not showing Pro-Circular Behaviours, which often is a consequence of their unfamiliarity and possible scepticism of circular business models. If consumers were more positive towards remanufacturing there would be a greater demand for circular products, meaning producers would be more inclined to implement circular business models.

This particular study measures the impact Persuasive Communication has on influencing the Behavioural Attitudes, Product Perceptions and Behavioural Intentions towards the purchase of remanufactured RDCs. Participants in this study are individuals who work directly and indirectly with the Food and Retail Refrigeration Industry, including and not limited to engineers, procurers and academic experts of retail refrigeration equipment. This paper demonstrates how effective this type of BCI could be, if developed further to create a target market and generate demand for remanufactured RDCs.

The study was carried out in three consecutive stages. In the first stage participants completed a questionnaire, which assessed their Behavioural Attitudes, Product Perceptions and Behavioural Intentions. In the second stage participants were

exposed to the intervention, which was the Persuasive Communication in the form of an audio-visual presentation. In the third stage participants completed a second questionnaire which assessed the impact of the intervention. The results show that the Persuasive Communication had a positive and statistically significant impact on the participants Behavioural Intentions towards the purchase of remanufactured RDCs. The intervention also proved to be effective in changing their Behavioural Attitudes and Product Perceptions.

This paper encourages further research into the application and influence of Persuasive Communication in other circular business models across various manufacturing and service industries.

Keywords: Circular economy, Pro-Circular Behaviour, Behaviour change, Persuasive communication, Circular business models, Remanufacture

Mitigating coal dependence in China by facilitating municipal solid waste incineration in industrial parks: A life cycle perspective

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Abstract:

Reducing coal dependence of Chinese industrial parks is crucial to mitigating their environmental footprint. Municipal solid waste incineration is a promising measure for such purpose and has been increasingly implemented in Chinese industrial parks. In the study, the list of in-use stocks of MSW incineration (MSWI) facilities in Chinese industrial parks was established for the first time, which accounted for 54.5% of the total MSWI capacities in 2014. The life-cycle environmental impacts of MSWI in a typical Chinese industrial park were assessed, associated with critical literature comparison and a sensitivity analysis. Four impact categories in LCA were evaluated, including global warming potential, human toxicity potential, acidification potential, and eutrophication potential. Then the LCA results were applied to the in-use stocks of MSWI facilities in industrial parks to uncover the potential environmental benefits during their remaining service lifetime. The results indicated that the in-use stocks of MSWI facilities in industrial parks have positive environmental benefits for the first three impact categories, while negative performance for eutrophication potential mainly due to inadequate implementation of end-of-pipe pollutants control. MSWI-driven combined heat and power (CHP) in Chinese industrial parks could achieve a 32% reduction in GHG emission as compared with coal-fired CHP with same outputs. The replaced coal consumption of the in-use MSWI stocks during their remaining lifetime is about 2.6% of total coal consumption of China in 2014, and the greenhouse gas (GHG) mitigation potential was estimated as 93.5 million ton of CO_2 eq., equivalent to 0.83% of GHG emissions of China.

Keywords: Industrial park, Municipal solid waste incineration, Energy infrastructure, Life cycle assessment, Vintage stock model

A global overview of critical metals resources–Opportunity and challenges

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Abstract:

The term 'Critical metals' (CM) signifies metals that are vital to modern technology and sustaining our expected standard of living. Ensuring the sustainable CM resources utilization, consumption & residue management is the crucial foundation for global-scale climate change mitigations, low carbon technology implementation and renewable energy generation (e.g. Wind turbine, photovoltaic systems).

In this abstract, we access the global resources of four CM, namely, rare earth elements (REE), the platinum group elements (PGE), Cobalt (Co), & Indium (In) and associated opportunity and challenges. Our complication identifies current global resources of 619.5 Mt of total rare earth oxides plus yttrium oxide (TREO + Y), 105,682 t of PGEs, 26.8 Mt Co & 356 kt of In with explicit information of hosting geological condition and mineralogy of these metals. Contradicting the conventional beliefs that CM supply risks are dominated by geological scarcity, our assessment suggests the real challenges lie within the sustainable production, consumption, and management of these vital metals.

Keywords: Critical metals, Rare earth elements, Platinum group elements, Cobalt, Indium

End of life of wind energy systems: A regional case study

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Abstract:

The European Union (EU) seeks to have a 20% share of its energy consumption from renewable energy by 2020. Among all, onshore wind energy is the most promising renewable energy source used nowadays. It has reached a technological and economical maturity level that allow a wide penetration in the energy mix. France is an example where onshore wind energy has reached a high penetration in the national energy grid. It is one of the pioneer countries where onshore wind energy started to be implemented since 2000. However, onshore wind energy systems have a limited lifetime duration (about 15-20 years) and France; like other countries; is facing a challenge regarding the End of Life (EoL).

In this study, three major EoL scenarios are considered for wind energy: decommissioning, revamping and repowering. While revamping and repowering required a partial or total replacement of wind plants, decommissioning requires the dismantling of the wind energy system. After this process, materials (e.g., steel and iron, aluminum, copper, polymer etc.) extracted from wind energy plants are recycled, incinerated or landfilled.

In Champagne-Ardenne (CA) region, one of the windiest territories in France, onshore wind plants highly penetrate in the national energy mix. They represent more than 20% of the global installed onshore wind plants in the Country. However, EoL scenarios using the dismantling process are still facing issues. From one hand, all wind plants components cannot be recycled. Materials like blades and foundations are not recycled, nor reused for revamping or repowering scenarios. From the other hand, maintenance activities during wind plant lifetime generate materials outputs that should be considered in decommissioning processes. Thus, the objective of this work is to quantify over time materials stocks and flows for CA region, including all wind turbines types and capacities and their maintenance flows.

An extensive data analysis of onshore wind plants installed in the CA region from 2000 to 2016 has been analyzed. In CA region, wind turbines installed capacity vary from 0.85 to 3.3 MW. Besides, a dynamic material flow analysis is used to quantify material stocks and flows for each year. Furthermore, three maintenance scenarios over wind turbines lifetime were considered to generate all extra materials. Finally, wind plants materials EoL scenarios were separated into recycling, incinerating and landfilling materials.

Our results show that more than 1 million tons of materials inputs were required for

all CA wind turbines. During 15 years of lifetime operation of wind plants, and according to the maintenance scenario used, EoL material outputs were generated. Results also show that the cumulative specific materials disposed for landfilling can be up to 600,000 tons.

Keywords: Wind energy, Material flow analysis (MFA), End of Life, Wind turbine wastes, Maintenance, Recycling

Development and application of water footprint methodology for expressway and railway infrastructures

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Abstract:

As the population increases in the world, the water consumption is increasing and the availability of water resource is likely to decrease. Therefore, to manage and reduce water consumption, the study on water footprint was started mainly focused on the agriculture and livestock products which are high water usage sectors.

The aim of this study is to develop the characterization factor and calculate the water footprint in expressway and high-speed railway. With these study purposes, the characterization factors were developed in 6 classified watersheds which are Han river, Nakdong river, Gum river, Seumjin river, Youngsan river and Jejudo about surface water and ground water considered characteristic of domestic water resources. As a result, the characterization factors of ground water in each watershed are 0.073, 0.127, 0.118, 0.045, 0.154 and 0.170. The characterization factors of surface water in each watershed are 0.074, 0.115, 0.256, 0.142, 0.235 and 0.245.

The water footprint on the basis of 1 km of expressway by Boulay's methodology (Boulay), MOE's methodology using Ecoinvent (MOE A), MOE's methodology using domestic LCI DB (MOE B) and developed methodology on this study (Kim) is 58,804 m^3, 42,036 m^3, 27,461 m^3, 15,313 m^3 H_2Oeq. and the water footprint of high-speed railway is 490,551 m^3, 307,548 m^3, 55,988 m^3, 116,631 m^3 H_2Oeq. because of amount of materials and differency of water consumption coefficient. The result of sensitivity analysis by reducing 10% of key issue is expressed to be reduced from 1.87% to 7% in expressway and 6.67% to 9% in high-speed railway.

The future prediction of water footprint in 2020 was from 0.04% to 0.17% of total water demand in domestic expressway and from 0.22% to 0.86% in domestic road. The water footprint by Boulay was 3.9 times higher than by Kim. In 2025, it was from 0.01% to 0.05% in domestic expressway and from 0.10% to 0.74% in domestic road. The water footprint by MOE B in domestic road was 7.5 times higher than by Kim. The difference between 2020 and 2025 is because the annual average increased distance to 2020 is relatively longer than to 2025. The result of sensitivity analysis in 2020 and 2025 by reducing 10% of key issue was expressed from 1.91% to 9.90%

The predicted water footprint in 2020 was from 0.01% to 0.06% of total water demand in domestic high-speed railway and from 0.10% to 1.00% in domestic railway. One of 2026 was from 0.01% to 0.06% in domestic high-speed railway and from 0.05% to 0.33% in domestic railway. The water footprint by Boulay in 2020 and 2026 was 8 times higher than by MOE B in domestic high-speed railway and in 2020 9 times and in 2026 11 times in domestic railway. Difference of 2020 and 2026 is because of water footprint in the material production and construction. Result of sensitivity analysis in 2020 and 2026 about domestic high-speed railway by reducing 10% of key issue expressed to be reduced from 6.37% to 9.8% and about domestic railway from 9.2% to 11.9%.

Keywords: Water footprint, Expressway, Railway

Decision-making model on sustainable supply chain finance in uncertainty

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Abstract:

Supply chain finance has gained its popularity, yet the combination of sustainable development and supply chain finance are receiving attentions. This study describes the understanding towards supply chain finance and sustainable development, analyzes the existing problems and deficiencies of these financing patterns and finally, this study applied Technique for Order of Preference by Similarity to Ideal Solution (fuzzy TOPSIS) to making the model on sustainable supply chain finance in uncertainty on proposed measures. A set of 14 criteria is introduced from four aspects includes economic, social and environment. Under the experts' opinions, the result presented that economic has the strongest significant power that drives other aspects. Also, indicate that trade credit, cash management, inventory control, raw material procurement, service delivery management policies are the most effective tools to enhance the sustainable supply chain finance. Besides, theoretical and managerial implication are also discussed.

Keywords: Sustainable development, Supply chain finance, Triple bottom line, Fuzzy TOPSIS

Environmental impact and intervention mechanism of Antarctic human activities

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Abstract:

Antarctica is crucial for global climate change and the safety of humankind. With the enhancement of human activities intensity in Antarctica, its impact on the ecological environment is spreading in scope and shifting in level. The establishment of effective intervention mechanism to reduce the environmental impact of human activities in Antarctica is the key problem to be solved in this study. This paper comprehensively reviews the environmental impact of Antarctic human activities, analyzes the intervention and limitations of the Antarctic Treaty System on Antarctic human activities, and proposes relevant policy recommendations on establishing an intervention mechanism for Antarctic human activities. These studies showed that Antarctic tourism, Antarctic expedition and Antarctic fishery resource exploitation are the three main forms of current Antarctic human activities; Antarctic human activities have had a significant negative impact on the fragile ecological environment of Antarctica; Antarctic Treaty System is not enough to deal with the negative impact of Antarctic human activities; By constructing method system of carbon footprint of human activity in Antarctic, this study try to quantify the environmental impact of human activities, so as to establish operable intervention mechanism of human activity in Antarctic; Based on the theory of organizational behavior, this study explore the mechanism of human activities in Antarctica, whose main feature is public participation, and secondary features are administrative control and market incentives; Furthermore, the intervention mechanism is established using the principal behavioral analysis method and is thus according with the wishes of different stakeholders. Finally, the development of a low-carbon-oriented national Antarctic strategy is helpful to enhance China's voice in Antarctic affairs.

Keywords: Antarctic human activities, Environmental impact, Intervention mechanism

Life cycle assessment of three Peruvian cement plants: Towards a more sustainable use of resources

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Abstract:

The construction industry is an energy and material intensive sector, which produces a great depletion of natural resources, and as a consequence, environmental impacts. In particular, cement is one of the most common construction materials contributing to 5-10% of the worldwide anthropogenic CO_2 emissions and to 12-15% of total industrial energy use (Hossain et al., 2017). In addition, more than a half of the CO_2 emissions linked to this sector are generated in the clinker production stage due to the use of fossil fuels and direct clinkering emissions. To face this concern, it is necessary to design a more sustainable product, improving the environmental performance of the manufacturing process under a life cycle thinking approach.

This study analyzed and compared the environmental impacts of Peruvian cement production to identify the main hotspots of the process throughout the whole supply chain. Life cycle assessment (LCA), a powerful tool based on the ISO 14040 and 14044 standards (ISO, 2006a, 2006b), was used to quantify all relevant emissions and resource depletion associated with cement production. The Peruvian cement industry represents 74% of the total construction sector, generating 3,813 t CO2 eq. (Ministerio del Ambiente, 2012). Three different types of cement produced in three different industries were analyzed: ordinary Portland cement (cement industry 1), cement with added natural pozzolan (cement industry 2) and cement with added blast furnace slag (cement industry 3). Two functional units were defined, 1 kg of clinker and 1 kg of cement, and the LCA was performed from cradle to gate.

Results indicated that the use of natural gas in cement industry 1, reduced 15% the emissions of greenhouse gases per kg of clinker compared to cement industry 2, which used coal. However, cement industries 2 and 3 presented a lower global warming potential impact per kg of cement than industry 1 due to the use of natural pozzolan and slags. These results highlight that the use of more efficient energy sources and the application of a circular economy approach improve the environmental profile of cement production.

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Keywords: Clinker, Furnance slag, Life cycle assessment, Portland, Pozzolan

Food-energy-water-climate nexus approach for the food waste management decision

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Abstract:

The current pattern of natural resources exploitation to meet humanity's demand for food threatens long-term food security. Food systems consume 30% of energy use and 70% of global freshwater withdrawals (Verma, 2015). In addition, they are responsible for around 30% of greenhouse gas (GHG) emissions. According to FAO, a third of all food produced globally for human consumption is lost or wasted (c.a. 1.3 billion tonnes per year (Gustavsson, 2011)). In the European Union (EU), around 88 million tonnes of food are wasted annually, with associated costs estimated at 143 billion euros. Food wastes over the food supply chain (FSC) represent a significant loss of resources invested in food production, transport and storage. In this sense, a more efficient use of resources is required to reduce waste generation and the related environmental damage.

This work proposes a new approach to assess food losses and waste (FLW) according to their impact on food, energy, water and climate systems. The evaluation of the trade-off and synergies described, require tools to quantify the relationship among these systems. Currently, there is no universally recognized methodology for nexus analysis. However, a life cycle thinking approach is essential to understand the interconnections in the nexus. Life cycle assessment (LCA) enables consideration of whole FSC which are increasingly globalized, with the production and consumption often occurring in different parts of the world and affecting the nexus in differing ways, depending on the region. The methodology developed is based on the following steps: (i) definition of the system boundaries, functional unit, allocation procedures and considerations, (ii) data collection and (iii) definition of the indicators used (i.e. nutritional content, energy and water consumption and global warming potential) and (iv) combination of optimization and linear programming to obtain an integrated Food-Energy-Water-Climate Nexus Index (FEWCNI). Eleven food categories are considered (cereals, sugar, vegetable oils, vegetables, fruits, pulses, roots, dairy, eggs, fish, and meat) at the distinct stages of the FSC (agricultural production, postharvest and storage, processing, distribution, consumption). The proposed index provides an understandable measure of the environmental and

nutritional performance of food, identifying critical food categories and supply chain stages. This index would facilitate the decision-making process, contributing to a straightforward identification of the most sustainable option for food waste management.

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Keywords: Food losses, Life cycle assessment, Nutritional content, Supply chain

Using industrial ecology to promote regional sustainable development

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Abstract:

Industrial Ecology should be considered as a key and basic base for promoting regional sustainable development, particularly given the background of constructing Ecological Civilization in China. In the 19th National Congress of the Communist Party of China, President Xi Jinping proposed an ambitious blueprint of ecological civilization, and explicit that “Ecological Civilization” is the party’s long-term approach to domestic development. As a systems-based, multidisciplinary discourse that seeks to understand emergent behavior of complex integrated human/natural systems, industrial ecology in regional sustainable development is being more and more important. By focusing on the area of Northeastern China, which is one of the most typical old industrial base in whole China, we conducted series studies by employing the Industrial Ecology principle and methods for promoting regional sustainability, for example, to analyze the global warming impact from magnesia refractory enterprise actual production process, to map the heavy metal pollution in brownfield development, to explore the mixed functions of land use in brownfield redevelopment and propose a new land-use coding system, and to evaluate the overall performance of such a brownfield redevelopment site by observing its evolutional changes. We found that, the idea of industrial ecology should be taken as a key approach for the revitalization in this area. However, we also found that more challenges actually arise and need to be addressed, for example, how to build a unified data-mining system for supporting decision making, and how to narrow the gap between science and policy makers? Therefore, more efforts need to be done in the future. We argue to build more knowledge-sharing networks for achieving this target.

Keywords: Ecological civilization, Circular economy, Resources management

Health and economic effects of wildfire in US in 2011

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Abstract:

Nowadays wildfire is the largest source of air pollutants that greatly changes landscape with impacts on human health, large scale climate changes, social economy and ecosystem in the U.S. The Community Multi-scale Air Quality (CMAQ) model is applied to simulate potential impacts on air pollutants due to wildfire in 2011. The National Emissions Inventory (NEI) 2011 is used to generate anthropogenic emissions with the Sparse Matrix Operator Kernel Emissions (SMOKE) emission processing model. The wildfire emissions are generated based on the fire inventory from National Center for Atmospheric Research (NCAR). Contributions of wildfires to air pollutants concentrations are quantified and the estimate health and economic outcomes are estimated using the US EPA developed Environmental Benefits Mapping and Analysis Program (BenMAP). Premature mortality, non-fatal heart attacks, aggravated asthma and economic risk are estimated to represent impact of wildfire and help to improve air quality controlling strategy.

Keywords: Wildfires, Air quality, Health risks, Economic cost

Industrial energy consumption intensity of Guangdong Province in China: An analysis based on hybrid-units input-output model with energy real term flows

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Abstract:

Both socio-economic development stage and resource endowment in Guangdong province are typical and representative in China. This paper analyzes the energy intensity of industrial sectors in Guangdong province to identify Guangdong's high energy consumption industries effectively and explore typical provincial experiences for energy conservation in China. A hybrid-units input-output model is established by introducing energy real term flows (in physical units) into traditional IO table in currency units to measure the direct energy intensities and total energy intensities of 23 industrial sectors in Guangdong province in 1997\2002\2007\2012\2015. The empirical results show that energy efficiencies of most industrial sectors in Guangdong Province have been improved in varying degrees during the past two decades. The top 4 industries with the largest decrease in total energy intensities were Food Manufacturing and Tobacco Processing, Metal Products, Manufacture of General-purpose and Special-purpose Machinery, Smelting and Pressing of Metals, whose total energy intensities decrease 66.27%, 65.49%, 64.05%, 63.85% respectively, while the total energy intensities of Energy Production and Processing merely decrease by 7.01%. Nonmetal Mineral Products, Smelting and Pressing of Metals, Chemical Industry, Textile Industry rank top 4 industrial sectors by the total energy intensities, while Other Industries, Farming and Forestry and Animal Husbandry and Fishery, Wholesale and Retail Trade and Catering Services have lower total energy intensities in all periods. Total energy intensities for the Construction, Electrical Machinery and Equipment Manufacturing, Manufacture of General-purpose and Special-purpose Machinery are much higher than their direct energy intensities because these industries consume a large number of high energy density products as intermediate inputs. Therefore, it is an effective way for Guangdong Province to achieve overall energy conservation and maintain sustainable growth by properly reducing the investment in the high energy consumption sectors.

Keywords: Energy input–output analysis, Hybrid input–output table, Energy intensity, Guangdong province

Material stocks change towards a cleaner power system of China

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Abstract:

China's power system serves the largest population in the world by supplying the largest amount of electricity. Resource and environmental effects generated by the power system are the key topics of sustainable development. In 2015, electricity generation in China reached 57,399 billion KWh, and the installed generating capacity reached 1,525 BW. Among the installed capacity, thermal power, hydropower and new energy accounted for 66%, 21% and 13% respectively. In order to transform to be cleaner and more intelligent, China's power system needs to build a large number of infrastructures and consume a certain amount of materials every year. The analysis of material stocks and material flows of China's power infrastructures can provide theoretical and practical basis for a cleaner power system, such as material reduction, waste management and generation of low carbon electricity. Based on the list of infrastructures for power generation, transmission and distribution in China during 1980-2015, this paper uses the top-down assessment method to evaluate the stocks of major metal and nonmetal material in power system. In addition, the material stocks are forecasted to 2030. It is found that the material stocks of power system have increased from 54.73 Mt in 1980 to 990.89 Mt in 2015, with an average annual growth rate of 8.6%. And the average annual growth rate reached 11.6% during 2005-2015, which was the fastest growth period since 1980. The largest proportion of the total material stocks is cement (about 80%), followed by steel and iron. The stocks of aluminum and copper are increasing due to the rapid construction of trans-regional transmission and distribution facilities. With the clean transformation of power system in China, the material stock of thermal power will reach its peak around 2020, but the material stocks of wind power, solar power and pumped storage power plants will keep growing all the time. The material stock per unit installed capacity has been decreasing since 1980, but it may increase after 2020, because renewable energy generation technologies, such as wind and solar energy, require more facilities for energy storage and long distance transmission. With the growth of material stocks in power system, the scrapped materials will also increase substantially. Therefore, we propose to develop recycling and reuse industrial chain so as to achieve recycling of scrap materials from the infrastructures, and save energy and reduce emissions in the life cycle of electricity.

Keywords: Power infrastructures, Material stocks, Renewable energy, Energy transformation, China

Biofuel production by using waste nitrogen via constructed wetland in China

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Abstract:

Current biofuels have offered promising alternatives to gasoline while lead to environmental consequences and energy consumption by means of nitrogen (N) fertilizers. Therefore, such biofuels are not as 'clean' as expected. Hence, new ideas those produce biofuels using from the municipal and industrial wastes and yard waste wood, can provide energy without N requirement (or N-neutral) and are environment-friendly for biofuel production. Here, we emphasize biofuel production by using waste N from domestic wastewater via constructed wetlands (CWs) for treating wastewater. In a CW, biomass is produced together with the pollutants (especially waste N) removal, and thus can be harvested and used for biofuel production. Although CW systems for wastewater treatment extended dramatically worldwide, the researches on biofuel production via CWs are rarely seen. Considering the enormous amount of current domestic wastewater discharge and its rapid increasing in future, the potential and feasibility analysis by using waste N for biofuel production is worthwhile evaluating.

In this study, we calculated the biomass production from CWs, and through life-cycle analysis (LCA), estimated net energy balance in CW biofuel production. Our study shows that the biomass energy yields of constructed wetland at present could reach 381 GJ ha^{-1} yr^{-1} as the by-product of treating wastewater, a factor of 4-17 higher than current biofuel production systems (21-95 GJ ha^{-1} yr^{-1}). Across full life cycles, renewable energy output from CW is about 500% greater than energy input for production. Supposing 2.02 Tg waste nitrogen in domestic wastewater discharged in 2017 were all treated by CWs in China, potential biomass power generation production could reach 300MW, accounts for 54% of renewable power generation. Coupling biofuel production and waste nitrogen removal can promote sustainable development of energy and environment.

Keywords: Biomass power generation, Biofuel, Nitrogen, Wetland

Spatial spillover effects of environmental pollution in China's central plains urban agglomeration

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Abstract:

Promoting the rise of Central China is one of the most important national strategies to promote China's economic development. However, the environmental issues in central regions have become remarkably severe. It is therefore worthwhile exploring how economic development and environmental protection can be coordinated. Focusing on the 29 prefecture-level cities in Central Plains Urban Agglomeration, the authors use a spatial auto-correlation model and the Environmental Kuznets Curve to empirically analyze the relationship between economy and environment from 2004 to 2014, combining the global spatial correlation test. The results show that: (1) A strong spatial correlation exists between industrial wastewater discharge, industrial sulfur dioxide and dust emissions in Central Plains Urban Agglomeration; (2) The relationship between the economy and environment of this urban agglomeration reveals an inverted "U" curve, which confirms the classical Environment Kuznets Curve hypothesis. Industrial dust emission has surpassed the inflection point of the Kuznets curve, but its spatial spillover effect still remains strong. This is caused by an accumulation effect and a lag effect; (3) The proportion of the secondary industry and population has a strong positive effect on pollution discharge; investments in science and technology have a certain inhibitory effect on industrial sulfur dioxide emission. Moreover, an increase in the number of industrial enterprises has a negative effect on industrial wastewater emission. At the end, the authors put forward policy recommendations regarding the establishment of a joint supervisory department and unified environmental standards at the regional level to deal with the spillover effects of pollution.

Keywords: Central plains urban agglomeration, Environment Kuznets Curve, Spatial auto-correlation model

Exploring the future of CCU by combining an international Delphi study with local scenario development

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Abstract:

In this article we identified the factors which according to international experts will have substantial effects on the general future developments and commercialization of carbon capture and utilization (CCU) technologies. A two round online Delphi study with 15 international experts in the field of CCU enabled us to explore the main items within five impact categories, being: (1) benefits, (2) risks, (3) future developments, (4) demand and (5) supply constraints. Based on the results of the Delphi study we subsequently constructed four future scenarios which represent how the CCU sector could look like in 10 years using a local scenario development workshop with experts from within Flanders (Belgium) and the Netherlands. We used a deductive, explorative scenario development method, which resulted in a 2x2 scenario matrix. The results of the Delphi study, all four scenarios and their implications for existing and future businesses are presented. Our insights are valuable and timely for facilitating the process of scenario planning for CCU development activities. Finally, although we worked with a regionally specific case study, the same method could be implemented in other regions, using the general findings from our Delphi study as a starting point for the scenario development.

Keywords: Carbon capture and utilization, Delphi study, Scenario development, Forecasting

Direct reduction and extraction of iron from nickel smelting slag and preparation of cementing materials using gangue composition

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Abstract:

In the nickel smelting process, fayalite ($2FeO \cdot SiO_2$) is produced as the main component of industrial waste products. The accumulative amount of nickel slags was more than 40 million tons and increases by the rate of 2 million tons per year. Nickel slag is a great potential secondary iron ore resource, with iron content of 20-40% and SiO_2 content of 30-50%. At present, nickel slag is mostly treated in the way of stocking, because of complex mineral composition and comprehensive utilization difficulties, thus causing environmental pollution problems. Based on the characteristics of nickel slag which has a large number of iron and SiO_2, this proposes to conduct research on combining the processes of direct reduction iron based on coal using nickel slag and preparation of cementing material which is mainly composed of belite (C_2S) and alite (C_3S). Using nickel slag of Jinchang in China as an example, analysis of thermodynamics calculation and experimental research were combined, and the process coupling between the reduction reaction of iron and the reaction of cementing material was achieved. Through reasonable contents and temperature control of roasting reduction reaction, single iron, alite (C_3S) and belite (C_2S) were acquired as the main reduction roasting product of nickel slag.

Keywords: Nickel slag, Direct reduction of iron, Alite, Belite, Process coupling

Rebound effect of energy intensity changes on energy consumption

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Abstract:

Energy efficiency can be represented by energy intensity, i.e., physical energy use per unit economic output. One percent energy efficiency improvement is expected to reduce one percent energy intensity and physical energy use to produce a given output. However, the real energy intensity and physical energy use may differ from the expectations due to output growth. How can we estimate the rebound effect of the energy intensity change? The present paper offers a method based on a general form of production function. The method does not require the assumption of profit maximization for producers. The energy intensity changes can come from both factor-augmented and factor-neutral technological improvement and substitutions between energy and other inputs in the production. Since energy intensity is affected by various factors other than pure energy efficiency improvement, backfire or considerable rebound effect can be easily observed in practice. On the other hand, super-conservation or negative rebound effect implies either a reduction in output or an increase in energy intensity.

Keywords: Rebound effect, Energy intensity, Technological improvement

Post-consumer cullet and potential engineering applications in North America

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Abstract:

Finding viable markets for post-consumer cullet generated in North America has been very challenging due to the predominant collection practice of glass commingled with other recyclables such as paper, ceramics, food particles, and glass of fluctuating colors and compositions. Thus, more than 60% cullet still ends up in the landfill. In this paper, potential end markets that could utilize this type of cullet with minimal level of processing have been identified. Based on several field trials conducted as well as the evaluation of the engineering properties, environmental impact, and safety issues, mixed cullet aggregates could be successfully blended with natural aggregates at different proportions for road-based applications, asphalt pavement, and concrete, utility and other construction projects. The debris level of the cullet aggregates for most of the applications should be maintained at 5%. Despite the vast potential end markets being identified, market demands still remain low. One of the major obstacles is the relatively high processing cost for cullet in comparison to competing natural aggregates. Therefore, to enhance recovery and develop strong market demands for cullet, there is a need for government interventions through the provision of recycling incentives, landfill ban, raising of tipping fees, and enforcing laws on the use of cullet as a construction aggregate.

Keywords: Cullet, Engineering application, Glass recycling, Aggregate

Impacts of coal-fired power plant retrofits on wind power integration and pollution mitigation: A case study of Jilin Province in China

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Abstract:

Wind power introduces variability into electricity power system. Due to lack of more flexible units, many regions of China rely on coal power to balance wind, mostly within provincial boundaries. To accommodate more wind power, an ancillary service policy was introduced in Northeast China in 2016 to encourage deeper cycling of coal power units, which soon motivated retrofits of multiple coal power plants to expand their cycling ranges. In this study, we intend to assess the impacts of these retrofits, if there is any, to wind integration and pollution mitigation. We use Jilin as a case study, and ask the following questions: (1) under current average dispatch system and various technical constraints, how much emissions could wind power displace? We recognize that frequent cycling and reduced capacity factor of coal power units lead to additional emissions, and we take these penalties into account when calculate environmental benefits of wind power. (2) Since retrofit of coal power units expands spinning reserves, Jilin grid should be able to accommodate more wind power - is that the case? How could we gauge the potential value of coal power to perform ancillary service? (3) As China proceeds to deregulate electricity market, how would transition from an average dispatch model to an economic dispatch model affect the above results?

To answer the first question, we use theoretical output data of a wind farm in Jilin province to calculate capacity credits of wind power at 15-minute intervals during typical days in January and August, with which we could deduce outputs for different capacities of wind power. To find emission reductions from wind power, we first construct a dispatch model that minimizes pollution emissions under constraints of supply-demand balancing, winter heating, coal power generator operating constraints, and reserve margin, based on principles of average dispatch and cycling. By feeding theoretical wind power outputs into the model, the optimization process returns output levels for coal power units and necessary wind curtailment rates at a chosen time interval for typical days in summer and winter. We then compute actual emissions from the system using heat-rate penalty curves of coal power, and derive emission reductions from wind power. Emissions and heat rate data are collected from actual coal power plants in Jilin province. For second and third questions, we modify the model and repeat the computations above. In particular, we would like to illustrate the relationship between coal power cycling range and wind curtailment for a given level of wind capacity.

The study contributes a Chinese case to the literature of emission implications of increased wind power penetration in a coal-intensive power system. It also provides policy implications to electricity market designs and assists construction of efficient generation portfolios in China.

Keywords: Sustainability, Coal power retrofit, Wind power integration, Environmental impacts, Power system flexibility

Characteristics of public concern about haze and its relationship with air quality in China

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Abstract:

Big data has caused widespread concern from academic communities and governments in China, and its application to environmental decision-making has also been vigorously promoted. Supported by search index statistics of Baidu, which is China's largest search engine, applied correlation analysis, lag correlation coefficient method and detrended method to analyze the relationship between haze and the public concern about it. The results indicate that: (1) From the long-term perspective, the Chinese public paid increasing attention to haze problems during the last seven years. After the large-scale haze in North China in January 2013, public concern about haze rose sharply, especially in winter and spring, that is much positively correlated to the fact that China is prone to haze in these two seasons. (2) From the short-term perspective, there was statistically significant cross-correlation between the public concern and PM2.5 concentration at lags ranging from 0 to 4 days. Along with the public concerning over the haze problems promoted, their reaction to haze eruption is getting faster and faster. (3) Several major cities in China have made some progress in air pollution control, but public concern about haze was still rising rapidly. The long-term trends of PM2.5 concentrations and public concern of haze are opposite but they have the same fluctuations in heavy air pollution weathers. Detrending the effects of long-tern series, air pollution and public haze concern has a high consistency with seasonal fluctuation.

Keywords: Haze, PM2.5, Air pollution, Public concern, China

China's energy-water nexus: Regional synergy of energy conservation on water resources

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Abstract:

As indispensable elements of economic development and social stability, energy and water resources are drawing increasing attention in China. Energy consumption could lead to issues of water shortage and inter-regional "water inequality", which have got wide attention from governments, enterprises and scholars. Studies on the relation between the two resources, known as the energy-water nexus, indicated that energy conservation had impacts on water resources. Energy conservation can bring synergy on water resources, but it is an issue that to what degree energy conservation efforts could indirectly protect water resources. In this work, we built an accounting framework to assess the synergy of energy conservation on water resources in each region. Synergies on both water quantity and quality were assessed via multi-regional input-output analysis. The results show that Jiangsu achieved the largest quantity of water saving with a volume of 63.7×10^{8} m^3, while Hunan achieved the largest quantity of wastewater reduction with a volume of 3.2×10^{8} m^3 during 2007-2012. The total synergy was divided into two aspects: internal and external, the former was generally larger than the latter in most regions except Qinghai, Ningxia, Xinjiang, Hainan, Shaanxi, Anhui and Inner Mongolia. Additionally, an economic assessment model was proposed to evaluate the economic benefit of synergy from a holistic perspective. The results show that China has achieved potential economic benefit of 1.1×10^{12} yuan through the synergy. Jiangsu, Shanghai, Fujian, Shandong and Heilongjiang were primary beneficiaries because of their large quantity of synergistic water saving and high shadow price of water resources. The proposed synergy assessment framework may help understand the situation of regional resources conservation from a synergistic and economic perspective.

Keywords: Energy-water nexus, Energy conservation, Synergy effect, Wastewater discharge, Multiregional input-output analysis, Economic benefit

Biofuel for vehicles: Using system dynamics modeling to evaluate government subsidy policies

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Abstract:

Biofuel development is constrained by several factors including the amount of land available, marketing of residual resources, and technological improvements. Of these factors, the main constraint is land. Economic feasibility and competition from other uses of residual resources limits the actual amount of residual re-sources that can be utilized to produce biofuel to a level far lower than the theoretical total resource volume. Therefore, numerous studies have been conducted regarding the potential to commercialize biofuels in the USA, Brazil, EU, and China, while other areas where harvests are limited are less discussed. However, de-spite the insufficient availability of land, biofuel commercialization has potential if a fair, mutually beneficial, and risk-sharing supply chain can be developed.

In this study, we develop a dynamic system model to explore the potential for commercialization in areas where harvests are limited. This model considers government subsidy policy, market demand, biofuel production cost, and social cost. Taiwan, a densely populated island with only limited natural resources, is used as a case study of E3 vehicles, which use a blend of 3% ethanol with 97% gasoline. Data needed for the analysis were collected from various sources including institutional statistics. The results show there is large commercial opportunity in Taiwan, where biofuel harvests are insufficient, if the government develops an appropriate subsidy policy to adjust prices based on market demand and technological improvements.

Keywords: Biofuels, Ethanol, System dynamic modelling, Subsidy policy

Strength and durability characteristics of steel fiber reinforced concrete

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Abstract:

Various concrete mixtures of steel fiber reinforced concrete (SFRC) were produced using hooked-end steel fibers with fiber volume of 0, 0.5, 1.0, and 1.5% while keeping quantities of other mix constituents constant. All concrete mixtures were tested in fresh and hardened state. Compressive, flexural, and split tension strengths were tested at the concrete age of 7, 28, 90 and 120 days. Durability of all concrete mixtures was evaluated at concrete age of 120 days using water sorption, freeze-thaw and abrasion resistance tests. Test results showed that workability and air entrainment (at equal dosage of air entraining agent) of the concrete mixtures dropped with increase in fiber volume percentage. Compressive, flexural and split tension strengths were recorded to be maximum at fiber volume fraction of 1.0%, whereas water sorption of concrete mixture with steel fiber inclusion increased with increase in fiber volume percentage. Weight loss of concrete specimens recorded after 300 freeze-thaw cycles was found to smallest in SFRC mixture with 1.5% fiber volume and largest in control mix (0% fiber volume). A similar trend was recorded in the case of abrasion resistance test.

Increase in strength of concrete mixtures with increase in steel fiber volume percentage points at the crack arresting ability of steel fibers. A well-dispersed system of steel fibers can thus effectively serve to mitigate the cracking in concrete specially cracking induced by temperature cycles and drying shrinkage. The enhanced resistance of SFRC to abrasion makes it a material for choice for flat concrete surfaces subjected to heavy erosion.

Keywords: Concrete, Steel fibers, Strength, Durability

China's provincial water intensity reduction targets allocation plan: From a fairness perspective

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Abstract:

China is a country with substantial differences in economic development, water consumption, water resources, industrial structure and technologies, as well as development path at provincial level. Therefore, China's provinces have different potential and degrees of difficulty to carry out water intensity reduction (WIR) requirements. In addition, interprovincial trade, with a large amount of embodied water, has become the fastest growing driver of China's total water consumption. Considering that China is experiencing significant urbanization and industrialization, it is anticipated that water consumption will keep increasing for quite a long time. WIR will, to some extent, influence the economic performance and social transition. An unreasonable WIR allocation plan will not only increase the water intensity, but also slow down China's economic growth as a whole. How to figure out a fair way to allocate provincial WIR duty has become a significant challenge for both policy makers and researchers. In this paper, ecological network analysis (ENA), combined with a multi-regional input-output model (MRIO), is adopted to build an ecological network of embodied water across 30 provinces. Then, by using flow analysis and utility analysis based on the ENA model, the specific relationships among different provinces were determined, and the amount of responsibility that a certain province should take quantified, with respect to the embodied water flows from interprovincial trade. As a result, we found that a large of embodied water flows existed within China's 30 different provinces, which reflects the causes of unfairness in the WIR tasks allocation. The underdeveloped provinces, such as resources provinces (Shanxi, Inner Mongolia etc.) and heavy industrial provinces (Liaoning, Hebei etc.), tend to export larger amounts of embodied water to developed regions than the volume of their imports. While developed provinces continue to take advantage from the interprovincial trade with less developed provinces by importing a large amount of embodied water. At same time, Control and Exploitation relationships are the major relationships existing among China's 30 provinces. For the developed provinces, the major relationship between them and other provinces is control, which means they should take responsibility for this ecological relationship. Therefore, developed provinces will undertake more responsibility for WIR tasks and underdeveloped provinces will decrease part of the WIR tasks in the new WIR allocation plan, which based on detailed data of interprovincial relationships and embodied water flows.

Keywords: Water intensity reduction allocation, Embodied water flow, Ecological network analysis

Sustainable coal consumption and production environmental indicator using life cycle analysis based fuzzy inference model: A Chinese supply chain perspective

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Abstract:

In recent years, sustainable coal consumption and production (ScCP) has received increasing attentions since coal-fired power generation plays a dominant role in power sector worldwide resulting in the largest amount of key air pollutants emissions. This highlights the importance of a precise environmental performance assessment indicator of electricity coal supply chain processes responsible for procurement of hard coal to coal-fired power plants to enhance decision and policy making processes for the involved stakeholders. A need for these kinds of indicators was also detected upon reviewing the literature related to SCP practices in energy sector calling for more practical and theoretical contributions. This forms our motivation to conduct this current research work. In this paper, an environmental performance assessment framework is proposed to serve as a practical decision-making system in evaluating the impacts of ScCP process environmental issues leading to an enhanced political and corporate level decision-making procedure. The proposed framework is formulated based on an integration of life cycle analysis (LCA) methodology with a developed fuzzy inference system (FIS) model which is applied on a Chinese electricity coal supply chain system as a real-world application to prove its effectiveness and applicability.

The framework encompasses two phases with the first phase commencing with defining the analysis objectives and scope together with establishing a life cycle inventory (LCI) for identified main processes. This is followed by the characterization process to produce an aggregated effect score with respect to the five identified environmental elements i.e. (1) global warning potential, (2) eutrophication potential, (3) photochemical oxidants creation potential, (4) acidification potential and (5) ozone depletion potential. Then, the calculated effect scores are processed using a proposed FIS model forming the second phase. Natural uncertainty that exists in effect scores provide justifications on utilizing fuzzy modeling within the LCA process. In this phase, the crisp values of the environmental elements (input variables) are converted into grades of membership functions. Next, a target range is configured for each of these input variables. A target range would be minimum and maximum values that input variables can obtain. It is notable that the input variables target ranges are not predefined in this proposed framework and can be defined based on several factors such as decision maker's expert opinions or case country or region's

environmental standards. In this research work, a triangular membership function is incorporated in the proposed FIS model for the input variables. The inputs for this fuzzy mechanism are then fuzzified based on a comprehensive knowledge consisting of various fuzzy rules. The computed fuzzified outputs are then defuzzified into a crisp number via output membership functions constructed using zero to one target range. The zero value is an indication of low environmental performance and one is interpreted as a high environmental performance. The final calculated score serves as an indicator which delivers a magnitude on the extent of environmental performance in the context of environmental uncertainty. Finally, a scenario-based analysis is conducted to identify alternative paths to mitigate environmental impact of the electricity coal supply chain.

Keywords: Sustainable consumption and production, Electricity coal supply chain, Environmental performance assessment indicator, Life cycle analysis, Fuzzy inference system, Sustainable supply chain management

Empirical study on decision-making mechanism of residents' household solid waste disposal behaviors

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Abstract:

Residents represent one of the key stakeholders in urban household solid waste (HSW) separation and recycling. Their participation in classification and recovery of HSW is a critical factor for the success of municipal solid waste management. In this study, a decision-making model for residents' HSW disposal behaviors is constructed based on social investigations, structural equation modeling (SEM), and discrete selection modeling. A questionnaire survey was conducted in five districts of Suzhou City, China. Based on the survey data of 709 residents and SEM method, the main factors that affect HSW disposal behaviors and their patterns were analyzed, followed by discussion on the underlying decision-making mechanisms. It is found that the behavioral selection has been closely related to four intrinsic factors (determined by individual choices) and seven external factors (determined by surroundings), and the combined effect of the latter ones is nearly twice of that of the former ones. Among all the factors, "environmental facilities and services" has the most comprehensive effect, while “publicity and education”, “convenience of recycling facilities”, “environmental awareness of residents” and “convenience of classification facilities” are the four most significant factors. Therefore, it is suggested that the comprehensive management of HSW should focus on improving the convenience of classification and recycling facilities, strengthening publicity and education on relevant knowledge, and improving residents’ awareness of environmental protection to promote residents’ participation. Moreover, the study suggests means to further promote urban HSW classification and resource recovery, including strengthening planning and construction of supporting facilities, integrating classification and recycling, and adopting nuanced recycling modes according to local conditions.

Keywords: Household solid waste, Separation and recycling behavior, Structural equation model, Social survey

Open-loop supply chains for automotive remanufacturing

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Abstract:

We argue that open-loop supply chains deserve more attention as a complement to closed-loop supply chains. Both can contribute to resource efficiency and environmental sustainability. We define an open-loop supply chain as a “system that maximizes value creation over the entire life cycle of a product including design, where the control and operation of the system, particularly reverse logistics, is open to a diversity of business actors”. This contrasts to close-loop supply chains that are run by a single supply chain owner.

We developed a simple theoretical framework to examine practices in automotive supply chains, looking at environmental impact over product life/reuse. Particularly, we mapped market actors involved in open- and closed-loop supply chains across the hierarchy from materials to components to products. Using the automotive sector as a reference, we then developed three case studies:

(1) Japanese used vehicles exported to and remanufactured in Chile from right-hand drive to left-hand drive operation; (2) A mechatronics part that is remanufactured to "better than new" condition for resale; and (3) Automotive alternators that are either directly reused as spare parts or are recycled for their copper value depending on market price.

Our work fills a void in sustainable supply chain management research around open-loop supply chains, and suggests a more adaptive management approach for end-of-life of products. Both open- and closed-loops can achieve displacement of primary resource extraction, and thus support sustainability objectives.

Keywords: Closed-loop supply chain, Sustainable supply chain management, Operations research, Reuse, Remanufacturing, Recycling, Automobile

Enhanced volatile fatty acid recovery in an anaerobic membrane bioreactor treating waste sewage sludge

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Abstract:

Anaerobic process is a promising method for waste sludge treatment to realize minimization and stabilization. As one of the products of anaerobic fermentation, volatile fatty acids (VFAs) have a highly economic value. VFAs can be used as the substrate of methanogenic, as great carbon source for biological nutrient removal, and for polyhydroxyalkanoates (PHAs) synthesis. It is economical to produce VFAs using sludge as substrate, with a cost of zero or even negative, but two aspects need to be improved: (1) the conversion rate into VFAs is not high enough, and (2) separation of VFAs from mixed fermentation liquor is still a challenge. Actually, if VFAs could be extracted from the fermentation liquor, the conversion process might be enhanced due to the elimination of end product inhibition. In this study, waste activated sludge was fermented in an anaerobic membrane bioreactor (anMBR) aiming for the enhancement of VFAs production and recovery.

The AnMBR consisted of an anaerobic fermentation reactor with a working volume of 3.7 L, and an internal membrane unit. The membrane used in AnMBR was polyvinylidene fluoride (PVDF) membrane with 0.1μm nominal pore size. The reactor was operated in semi-continuous mode under room temperature with a SRT of 6 days. The anaerobic reactor was agitated continuously with a stainless stirrer at 160 rpm, and the PH were left uncontrolled. At the beginning of the operation, membrane module was not used. In another word, the reactor ran as a conventional anaerobic digester. At the 30th day, the reactor reached a steady state. At the 43rd day, the membrane module began to be used for extracting supernatant with soluble compositions. During fermentation process, sludge samples were collected from the reactor at certain intervals for analysis.

No matter in conventional anaerobic digestion mode, or in AnMBR mode, acetic acid accounted for nearly 70% which was far more than propionic acid and butyric acid. In conventional anaerobic digestion mode, the VFAs concentration rose up to 1750 mg/L after the first thirty days start-up. In AnMBR mode, the VFAs concentration increased further to around 2700 mg/L, which was 1.58 times higher than that of the conventional mode, and the increase of acetic acid is the main reason. The increase of VFAs in AnMBR mode might be due to the alleviated end-product inhibition as most VFAs were sucked out of the bioreactor via membrane separation provided. Also, in AnMBR, the MLSS was greater because of the uncoupling of HRT and SRT. Greater MLSS means greater chances for microorganisms to contact the substrate in mixed liquor.

The degradation of VSS was also augmented. All solids and most of large molecules

such as proteins and polysaccharides could be intercepted by membrane for further hydrolysis and acidification. Due to the retention of the membrane, the enzymes and functional bacteria also get enriched inside the reactor. Both factors could contribute to sludge hydrolysis enhancement and the production of VFAs. Bacterial and archaeal community structures for different modes were also investigated and compared for mechanism analysis.

Keywords: Waste sludge reduction, Sludge anaerobic fermentation, Volatile fatty acids, Anaerobic membrane bioreactor

A hybrid approach to explore the critical factors influencing company sustainability from the government's perspective

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Abstract:

Concerning the environmental problems, companies pay more attentions to their sustainability for survival and development. The influential factors of sustainability therefore become the research focus for companies. However, the majority of the current research neglect the dual status of government, that is, the maker and arbitrator of the order of economic activities, as well as the main player in the market. As a result, few works consider the sustainable development of companies from the perspective of the government's requirements. Base on the Triple Bottom Line, Sustainable Consumption and Production theory, this paper develops a framework on the standpoint of government to explore the influencing factors of sustainable development of companies, providing scientific guidance for companies' decision-making. In addition, in order to overcome the semantic ambiguity, this study proposed a hybrid approach combines the Grey theory and other three methods to examine the effects of each criterion. A survey of 10 government officials with senior experiences in sustainable development is conducted. Grey Delphi method is used to screen the criterion. Results generated by the Grey Decision Making Trial and Evaluation Laboratory method show that among the factors affecting the sustainable development of companies, reducing exhaust emissions are the most fundamental driving factors. Results by Grey Interpretive Structural Model method indicate that improving strategic thinking ability is the priority for sustainable development. The suggestion of enhancing sustainable competition capacity of companies through improving the sustainable production capacity, environmental response capacity, and service support capacity is proposed.

Keywords: Critical factors, Company sustainability, Government's perspective, Grey decision making trial and evaluation laboratory, Grey interpretive structural model

Utilization of coal bottom ash in recycled concrete aggregates based self compacting concrete blended with metakaolin

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Abstract:

The current study examines some of the important properties of Self-Compacting Concrete (SCC) made with different proportions of Coarse Recycled Concrete Aggregates (RCA) in place of Natural Coarse Aggregate (NCA) along with incorporation of Coal Bottom Ash (CBA) as replacement of Natural Fine Aggregates (NFA). The results indicate that the incorporation of CBA with presence of RCA in place of NCA does not impart any detrimental effect on the overall performance of SCC. The investigation also inferences that an equivalent performance has been achieved for SCC made with the incorporation of CBA along with RCA against NCA up to 50% in terms of compressive strength, tensile strength, resistance towards electrical resistivity, capillary water absorption and ultrasonic pulse velocities at 28 days of curing. The addition of Metakaolin (MK) has been found to compensate the observed loss in the performance of SCC at higher replacement levels since an improved performance against all aforementioned properties has been achieved even at full replacement (100%) of NCA with RCA. Based on the experimental observations, SCC made with industrial waste (RCA and CBA) / by-products (MK) leads to economy and sustainability in upcoming concrete industry.

Keywords: Coal Bottom Ash, Self Compacting Concrete, Recycled Concrete Aggregate, Metakaolin

Environmental and economic assessment of lightweight aggregates production from solid wastes

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Abstract:

The lightweight aggregates are primarily manufactured by sintering process and alkali-activated process, and the raw materials have gradually turned from nature materials to various solid wastes by adopting the green building materials strategy in China.

In this study, the environmental and economic impacts of manufacturing processes of lightweight aggregates are assessed by using life cycle assessment and life cycle costing approach in the system boundary of “cradle-to-gate”. The assessments were performed by software GaBi 4.0 and with life cycle assessment method EDIP 2003. The data for mass and energy balances and exhaust emissions were collected from existing plants in China as well as literature.

The results show that the overall environmental impacts of alkali-activated process are lower than that of sintering process due to the low energy consumption, while the environmental category of freshwater ecotoxicity contributed from the caustic soda used as activator is significant. From the aspect of economic assessment, sintering process can obtain a significant benefit from treating hazardous wastes such as fly ash, even though its operational expenditure is not satisfying.

Through the integrated analysis of life cycle assessment and life cycle costing, we can reach the following conclusions. On the one hand, the alkali-activated process is preferred to produce lightweight aggregates from solid wastes, while its environmental impact could be reduced if decreasing the activator consumption or using other eco-friendly alternatives. On the other hand, the sintering process, which can benefit from the treatment charge, excels in treating hazardous solid wastes.

Keywords: Lightweight aggregates, Life cycle assessment, Life cycle costing, Solid wastes

Personal carbon trading: Mandatory or voluntary? A game model between government and individuals considering heterogeneous emotions

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Abstract:

In the context of low-carbon development, the implementation of personal carbon trading (PCT) scheme is urgently required with the continuous advancement of upstream carbon trading market. In this study, government and individuals were considered as game players, where government was programmed to play "mandatory pattern" or "voluntary pattern" strategy about implementation of PCT, and individuals were programmed to play "rejection" or "participation" strategy in face of PCT scheme. Then game model and numerical simulation were employed to analyze the influences of the heterogeneous emotions of government and individuals on their equilibrium strategies about the patterns for implementing PCT scheme. The findings show that the emotions of government and individuals cannot influence the Nash equilibrium of pure strategies, but do affect the Nash equilibrium of mixed strategies. (1) When government is rational and individuals are emotional, the equilibrium strategy of individuals will remain unchanged, but government will move towards "mandatory pattern" when individuals are optimistic and move towards "voluntary pattern" when individuals are pessimistic. (2) When government is emotional and individuals are rational, the equilibrium strategy of government will remain unchanged, but individuals will move towards "rejection" when government is optimistic and move towards "participation" when government is pessimistic. (3) When both government and individuals are optimistic, government will move towards "mandatory pattern", and individuals will move towards "rejection". (4) When both government and individuals are pessimistic, government will move towards "voluntary pattern", and individuals will move towards "participation". (5) When government is optimistic and individuals are pessimistic, government will move towards "voluntary pattern", and individuals will move towards "rejection". (6) When government is pessimistic and individuals are optimistic, government will move towards "mandatory pattern", and individuals will move towards "participation". Furthermore, policy suggestions were proposed to achieve a win-win result of government and individuals. This study not only provides valuable references for the research of PCT and the implementation of PCT, but also contributes to the achievement of the global carbon emissions reduction target.

Keywords: Personal carbon trading, Heterogeneous emotions, Mandatory pattern

Voluntary pattern, Rank-dependent expected utility

Measurement and influencing factors of urban residents' carbon capability: A case study of Jiangsu Province in China

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Abstract:

With the rapid growth of residential energy consumption, it is urgent to implement carbon emission reduction from the consumption side, which depends on the improvement of urban residents' carbon capability. In this study, the relevant literatures on capability and carbon capability have been sorted and the carbon capability has been classified into more detailed four dimensions: carbon knowledge capability, carbon motivation capability, carbon behavior capability and carbon management capability. According to the grounded theory, a quantitative research model of urban residents' carbon capability in Jiangsu was constructed. Based on this, a questionnaire survey was conducted, SPSS 19.0 and LatentGOLD were used to process the questionnaire data, and the carbon capability of Jiangsu residents was evaluated. The results showed that residents of Jiangsu Province were divided into six groups based on their different carbon capabilities. The six major groups accounted for 28.19%, 21.21%, 18.33%, 15.84%, 9.88% and 6.55% of the total sample, respectively. Gender, age, occupation and education level had a significant impact on the carbon capabilities of Jiangsu residents. However, annual household income and household population had no significant effect on residents' carbon capability. According to the characteristics of each cluster on the four carbon capability dimensions, the six clusters were named as "balanced steady cluster", "self-restraint cluster", "fully backward cluster", "comprehensive leading cluster", "slightly cognitive cluster" and "restraint others cluster". According to the evaluation standard, the qualified rate of Jiangsu residents' carbon capability reached 61.93%, and the excellent rate was only 15.84%. The relevant policy implications are suggested based on these conclusions.

Keywords: Carbon capability, Carbon capability measurement, Carbon capability assessment, Low carbon consumption, Influencing factors

Urban environment risk transmission simulation and management policy effect analysis in river basin scale

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Abstract:

The overall environment of river basin is increasingly affected by the economic development of the cities spawning river. The environmental risk control policies adopted by the river basin management agencies have significant effect on both the environmental conditions and the economic development of the cities in the river basin. In this paper, the multi-agent simulation method is used to analyze the environmental risk transmission process and the influence of river basin manager's relative policies. Different situations were considered in this paper, including the basic situation, the environment management ability, the response attitude and the intensity of mandatory policies. The results show that in the BAU scenario, more and more cities become environment risk transmitters due to the accumulation of environmental risk in the river basin, while the cities who take actions to protect environment also become environment risk transmitters. In the environment management ability scenario, the results show that the stronger the environmental management ability of river basin managers, the better the environmental governance of the river basin will be. In the response attitude scenario, the results show that if the river basin managers adopt a more positive response attitude in environmental risk events, the environmental risks will be treated better and more effectively. In the intensity of mandatory policies scenario, the results show that when the relevant management policies adopted by river basin managers are moderate in intensity, the environmental risk value of the entire river basin is at the highest level instead. The effect of environmental risk management goes better when the river basin managers do not take any mandatory policies. When the river basin managers take a more coercive policy, all local governments will jointly cope with pollution emissions, so that the pollution levels of the entire river basin will meet a state of compliance with the relevant standards, so as to achieve a more satisfactory pollution control effect .This research can provide a new idea for the study and formulation of relevant river basin management policies for river basin management agencies to promote further improvement of the overall environment.

Keywords: Environmental risk, River basin management, Policy, Netlogo, Economic development

Developing a "flow & stock-policy benefits" modelling framework of urban energy-water-food-land-climate change nexus: A case study of Beijing

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Abstract:

The acceleration of industrialization and urbanization process have brought significant environmental burdens such as climate change and resource scarcity in China. There is a great challenge on the increased demand for water, food and energy, the manner and extent utilized of which are also inseparably linked with land use as well as the climate change. Therefore, the efficient resource use and management is of great importance in the coming decades. An essential issue in management of the water, energy, food, land and climate change systems is that they have inextricable linkages. However, most studies are focused on the water-energy-food nexus so far, which fail to acknowledge many important variables and interactions with the land and climate change systems. Consequently, the interconnections between the five domains are not taken into account in the policy making process as well. Taking Beijing city as a case, this paper develops a “flow & stock-policy benefits" modelling framework of urban energy-water-food-land-climate change (EWFLC) nexus, demonstrating how these five sectors are in relation to each other. Meanwhile, policy analysis is conducted to target the policy coherence and avoid the policy conflicts. What’s more, different policy scenarios are provided to seek the policy benefits under the EWFLC nexus framework. In that case, suggestions on efficient resource management, which make sure the urban cities achieve a friendly and sustainable development over a long period of time can be proposed for our government accordingly.

Keywords: Urban, Energy-water-food-land-climate, Nexus, Policy

Characteristic of rural household food waste and its driving factors in Shandong Province, China: A survey-based research

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Abstract:

Food waste has attracted global attention because of its impact not only on the resource utilization efficiency and environmental issues but also on the social fairness and sustainable consumption. Chinese central government now are striving to advocate the green consumption and sustainable consumption patterns, of which reducing food waste is one of the quite important goals. The quantitative measurement of food waste is an important prerequisite to evaluate its comprehensive impacts and develop a reduction target. In high income countries, household food waste accounts for about half of the total food waste and becomes one of the biggest contributors to the whole food waste in the country. So what's the amount of household food waste in China? However, till now little is known about how much food Chinese people waste in their daily life, especially in the rural area. This leads to the fact that the general public don't have an accurate concept of household food waste. Considering the relatively low living standard of rural people, do they waste much food? If so, what's the characteristic and the reason behind? Vice versa.

Under the current background of "Rural Revitalization Strategy" in China, this paper attempts to analyze the three-day food waste data obtained from 207 rural households in 21 villages in 3 cities (each city 7 villages) in Shandong province which is one of the main grain producing areas in China. The survey was conducted by quantitative weighing tracking each family for three contentious days including two weekdays and one weekend day. The field survey lasted 29 days, and the content of the survey included information on family food consumption behavior characteristics, consumption concepts, access to food raw materials and food storage etc. Based on the data collected, we analyzed the difference of household food waste in different regions and different economic levels. Then statistical analysis method was used to study the causes of rural household food waste. We use regression analysis to determine the main factors of household food waste based on SPSS software. Finally, by comparing with the difference of food waste of foreign families and Chinese catering industry, the current situation and trend of food waste in rural family in China were discussed. The study found that the situation of household food waste in China is not as serious as the food waste in developed countries and Chinese

catering industry, with the amount of 1g per capita per meal in average food being wasted, and food waste per capita per meal varies considerably by households (from 0.02g to 14.02g). Accordingly, the total amount of household food waste throughout the year vary from 69g to 52.35 kg per household, and the average waste was 3.11kg per household per year. According to this average level, the total food waste of rural households in Shandong province would amount to 41,291 tons/year. The next step of the study will focus on sustainable consumption, green consumption patterns to improve household food use efficiency and other aspects of food use and waste.

Keywords: Food waste, Rural household, Driving factors, Quantitative weighing, China

Policy changes toward a circular economy in China

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Abstract:

The concept of a circular economy calls for decoupling of economic development from resource extraction and environmental impacts though holistic, efficient management of the stocks and flows of resources and energy. It has been widely integrated into policies, plans, and business practices in both European and Asian countries. Here we develop a conceptual framework for understanding the circular economy. The framework is used to categorize policy-making for the circular economy in China, where the policy efforts have been enduring and broad. We identify major policy changes in each type of circular economy policies. Combining the frameworks of fragmented authoritarianism and Kingdon's multiple streams, we investigate the factors and dynamics in policy changes and particularly the role that policy entrepreneurs played. Based on interviews and archival research, we find that both pressure and support from the international society were key factors that initiated the policy changes. International influences were quickly integrated into domestic policies because of the national interest and preference of policy entrepreneurs, which made China progressive in policy making. Fragmentation of the administrative system, however, led to confined policy initiatives that represent partial understanding of the circular economy. The holistic view of the circular economy is yet to be integrated in policy-making.

Keywords: Circular economy, Policy change, Policy entrepreneurs, Fragmented authoritarianism, Multiple-stream framework

An initiative on social and economic dimensions on climate change and carbon reduction

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Abstract:

The assessment of economic impact and social cost of climate change and carbon reduction has attracted widespread attention from academic fields and determination departments. In this paper, we firstly analyze the research status of economic impact and social cost of climate change and carbon emission on a global scale. Based on the global CO_2 nonuniform dynamic distribution, we then propose new economic theoretical methods, models and technology system on climate change. We further discuss on the temporal and spatial relationship between global CO_2 nonuniform dynamic distribution and land temperature, the evaluation of carbon emission space of major countries under global CO_2 nonuniform dynamic distribution and the evaluation of social and economic cost of carbon emission and carbon reduction in China under temperature threshold value of 1.5? and 2?. This research provides decision supports on formulating strategies carbon emission and carbon reduction, achieving climate change mitigation and sustainable transformation and promoting discourse right in response to climate change for China. The design of the research methods and technical route will effectively answer the key scientific problems: (1) How the global CO_2 nonuniform dynamic distribution affects the rising surface temperature? (2) How to develop new economic model and technology system on climate change? (3) How to calculate the carbon emission space in the main countries of the world under the temperature controlling threshold? (4) Taking justice, fairness, efficiency and historical responsibility into account, how to evaluate the social and economic costs of carbon emissions and carbon reduction and assess national differences?

Keywords: Global change, Carbon emission, Carbon reduction, Economic of climate change, Economic impact and social cost

Manufacturing conversion cost reduction using quality control (QC) tools and analysing real-time data through digitization

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Abstract:

Two-wheeler automobile manufacturers in India are currently facing a big pressure to reduce the overall manufacturing conversion cost in order to be more competitive in the global market. The manufacturing conversion costs include all indirect or direct production costs incurred on manufacturing processes that convert raw material to finished goods. The manufacturing conversion cost consists of four big costs (excluded labour cost) -product or parts scrap cost, consumable cost and tool cost. The scrap cost is the cost of defective product which are not produced in accordance with standard and can't be sent to market. The consumable cost is the cost of other than raw material which is used in manufacturing i.e. hand gloves, fuel, gases, chemical, coolant and lubricants etc.

The study has tried to illustrate that how a small amount of manufacturing conversion cost per vehicle gives a big impact on total manufacturing cost in long term when company is producing more than 7 million vehicles per annum. The case manufacturing comprises three main processes: machine shop, frame plant (weld and paint shop) and assembly shop. In frame plant, paint shop and weld shop are the two main sub sections of this automobile manufacturing and more than 60% of overall manufacturing conversion cost consumes in these areas.

The global leaders in two-wheeler manufacturer are coming up in India with innovative technologies and giving tough competition to existing manufacturer in India by producing with very low manufacturing cost. It is the right time for two-wheeler manufacturers to minimise their manufacturing conversion cost per unit by producing defect free product and optimizing the processes utilizing innovative techniques and digitization. The volume of vehicles in India has increased drastically during last two decades and increasing in the manufacturing conversion cost per vehicle could give adverse impact on business profit.

This research has emphasized on conversion cost reduction by which an organization can save the huge cost in manufacturing simply by using quality control tools and monitoring real-time data through digitization techniques. This paper discusses some of the Quality Control(QC) tools through integrations of digitization technology to get real time data recording used to achieve organization key results of reducing conversion costs by as much as 40% and increasing the direct as well as indirect productivity by 10%.

This paper attempts to reduce the manufacturing conversion cost by prioritizing and

analysing the sub factors using Quality Control (QC) Tools like pareto and cause & effect diagram methodology and real time data collected through digitization to eliminate the manual data recording errors. The process by process defect analysis to reduce the cost of poor product. It has also suggested alternatives of consumables like propane gas to natural gas, or multi processes to single process. The study revealed that the reduction in product scrap cost and consumable cost are the best opportunity for an automobile company to reduce the overall manufacturing conversion cost. This paper presents a case study of a world leading Indian automobile original manufacturer (OEM) company and discussed several examples to have better understanding of subject.

Keywords: Manufacturing conversion cost, Quality control (QC) tools, Original equipment manufacturer (OEM), Digitization

Securing raw materials supply and responsible supply-chains via certification

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Abstract:

We argue that certification and auditing can contribute to both responsible sourcing and to security of supply of raw materials.

Sustainability standards and certification approaches are examined beginning with the theoretical framework of the "tripartite standards regime." Reference is made to parallel scholarly efforts: Namiro, CERA EIT Raw Materials, and STRADE. Emerging mining, mineral and metal certification initiatives reviewed include: OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, the Responsible Minerals Initiative (currently focusing on the conflict minerals Sn, Ta, W, Au, and on Co and mica), the Aluminum Stewardship Initiative, and the nascent program of the China Chamber of Commerce of Metals Minerals & Chemicals Importers & Exporters (CCCMC). Overall, these efforts aim to mitigate concerns of human rights, forced labour, and financial crime – sustainability considerations are less prevalent, although recycling sources are often addressed. A major point of leverage used by supply chain initiatives is bottle-necks or pinch-points in global supply chains of minerals. For metals the pinch-point is the smelter or refinery, and it is companies at these operations that have been especially engaged to participate.

To examine issues of security of supply of raw materials, we developed case studies of metals companies that are concerned about both responsible sourcing and security of supply of raw materials. Case 1 is a US tungsten producer that secures "an independent raw material supply chain" from "tungsten mines across the globe" yet explicitly "[does] not source any tungsten or molybdenum ore from China or conflict regions in Africa [thus] ensuring a stable supply of raw material for … customers." Case 2 is a European processer of refractory and precious metals that strategically aims to be "independent from surging volatility and speculations on the raw materials market" and that has used "technology metal recycling to secure" supplies. A third case for a Chinese firm is provided in contrast.

In terms of security of supply of raw materials, we suggest that both social and environmental sustainability certification approaches can contribute to market access and reduced business risk of raw materials supply. Firstly, though transparency, certification increases understanding of material sourcing and supply, including both physical data and business information on actors and relationships in global markets. Second, certification motivates supply-chain improvements in social, environmental, and economic factors from upstream to downstream, which require communications, better management systems and business competency inside and between small

and large businesses involved in resource markets.

Our work fills a void regarding how approaches to sustainable resource management correlate to business risk and security of resource supply.

Keywords: Standards, Certification, Auditing, Supply-chains, Security, Transparency, Business risk

A review of green competitiveness: Research focus, trends and future research direction

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Abstract:

As “green” and “sustainable” become the new themes of regional economic development, green competitiveness (GC) will undoubtedly become a new engine for regions to solve environmental, resource use and other global problems to fit the new development themes. The variety of different frameworks and models adopted as well as a lack of analysis of the field suggest a need for a critical review of GC deification and evaluation. This study describes the research focus, trends found in present academic literature devoted to GC. A total of 1890 papers were retrieved and after a two-step identification, 36 papers were finally identified and analyzed in detail. With the shorting and deficiencies in the current studies noted, the results give a comprehensive picture of existing research on the topic, thus providing researchers with a solid foundation for further study and indications of the directions for further development.

Keywords: Regio, Green competitiveness, Index system, Literature review

Incorporating sustainability into soil contamination mapping: Life cycle comparison between portable XRF and ICP-MS

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Abstract:

Soil contamination by heavy metals poses a great threat to the environment. To restore the contaminated soil, site investigation for the soil contamination mapping is crucial. Currently, site investigation is typically performed through the use of off-site analytical technologies. This introduces the transportation of contaminated soil, the consuming of analytical reagent and the use of strong acids during digestion, resulting in low-efficiency, high resources and energy consumption and health risks to lab workers.

Sustainable remediation is a new movement in the remediation industry, which has drawn increasing attention in the last decade. There is an urgent need for developing more environmental friendly soil analytical technologies with higher efficiency, to incorporate the concept of sustainable remediation into site investigation. Life cycle assessment (LCA), a tool that has been widely used to evaluate the environmental impact of contaminated soil remediation, can be used to assess the sustainability of soil analytical technologies.

Portable X-ray fluorescence (pXRF) technique is regarded as a promising approach for on-site screening of heavy metal content in soil. It offers opportunities to increase the analytical efficiency by the immediate measurement of contaminants, and thereby lowering the materials and energy input for sample storage, transportation and analysis. However, the accuracy of soil contamination mapping by pXRF has not been fully understood. Therefore, studying the feasibility of pXRF application to site investigation is of great importance.

In this study, the feasibility of using pXRF for rapid and accurate site contamination mapping under various site conditions is investigated. The sustainability of site investigation via conventional off-site Inductive coupled plasma-mass spectrometry (ICP-MS) analysis and on-site pXRF analysis is compared in a life cycle perspective.

Keywords: Sustainable remediation, LCA, XRF, Soil contamination, Heavy metal

How to achieve a cooperative mechanism of MSW source separation among individuals — An analysis based on evolutionary game theory

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Abstract:

Existing research on Chinese government's intervention into municipal solid waste (MSW) source separation behaviors mainly concentrates on the one–to–many approach, which lacks specificity and timeliness. This study constructed a reticular cooperative mechanism of MSW source separation for the Chinese government that was influenced and supervised by individuals, and explored the formation conditions of the interpersonal cooperative mechanism in the process of MSW source separation using the evolutionary game method. The results show that during independent separation, individuals tend to exhibit "free-rider" behavior regardless of whether restraint measures were imposed by government, which result in the failure of government policy. In cooperative separation, the evolutionary stability strategy of individuals was cooperative separation or non-separation. Furthermore, an effective and stable cooperative relationship among individuals should be developed to promote the public's active participation in MSW source separation. The stability of this relationship was determined by cooperative costs and government restraints because cooperative benefit is a necessary factor to achieve this relationship. A numerical simulation was analyzed to verify the effects of parameters adjustment on the evolution of source separation behaviors. This study contributes to a new perspective and theoretical guidance for the Chinese government to guide individuals' MSW source separation behaviors, and provides valuable references for other countries about the management of MSW source separation.

Keywords: MSW, Cooperative separation, Independent separation, Government restraint, Evolutionary game theory

The measurement of energy efficiency and the evolution of spatial pattern in China

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Abstract:

By using both radial and non-radial EBM models, the energy consumption of all provinces in China from 2000 to 2014 is analyzed from two aspects of economic efficiency and green efficiency. And then reveal the mechanism of the regional differences in energy and green efficiency through the Theil index. We try to deconstruct the reasons of energy inefficiency based on the perspective of input decomposition, and we also measured the energy saving and emission reduction potential index of the provinces by the differences between the target value and the actual value. Finally, we study the dynamic evolution and spatial pattern of energy green efficiency in China using the ESDA model.

Keywords: Economic efficiency, Green efficiency, EBM models, Dynamic evolution

Do car restriction policies effectively promote the development of public transport?

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Abstract:

Traffic problems caused by the rapid growth of motor vehicle ownership has become an increasingly serious concern. Many cities have developed car restriction policies with an aim to relieving traffic pressure. In this paper, the policy effectiveness assessment method based on panel data proposed by Hsiao et al. (2012) was adopted to analyze the effect of car restriction policies on public transport development. In view of driving restriction policy, license plate restriction policy, and dual policy implementation of the former two at the same time, the research analyzed the influence of these policies on the development of public transport based on six selected cities in China. We found that driving restriction policy has increased public transport passenger volume by 5% - 25%, license plate restriction policy has no significant effect, and the dual policy mix has increased the volume of public transport by 20% - 30%, namely the dual policy mix can enlarge the policy effect. However, the results showed that car restriction policies have no significant impact on the proportion of public transport, which means that the restriction policies cannot improve the travel structure radically. That is, car restriction policies can merely serve as a kind of emergency measure, rather than solving the traffic problems from the source. Therefore, the proportion of public transport can be improved merely through improving the urban road planning, enhancing public transportation infrastructure construction, and improving residents' acceptance of public transportation.

Keywords: Driving restriction policy, License plate restriction policy, Public transport, Policy effects, Counterfactual evaluation

Bottom-up estimation of copper in-use stocks in Sichuan Province, China

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Abstract:

Copper is an essential industrial metal widely used in various fields from electronics, electricity, to transportation and construction. China is currently the world's largest producer of refined copper and importer of copper concentrate. Recycling of scrap copper can relieve China's reliance on primary copper resources and reduce the environmental burden. More efficient recycling can be achieved by investigating copper stocks in use.

This study attempts to estimate copper in-use stock in China's provincial administrative regions and provide a theoretical framework for the development of copper recycling industries. A case study was carried for Sichuan Province (one of the most populous province in China) by using a bottom-up approach.

The study calculates the copper in-use stock of 21 prefecture-level administrative regions in Sichuan Province in 2014. The total stock stocks amounted to 1.1 million metric tons of copper or 14 kg/capita, which was 55 times greater than the annual production of refined copper. The average stock per capita in Sichuan was far below the level of the developed countries, thus suggesting a big potential of growth in the future. Among 25 sub-sectors calculated, around 65% of the stock stayed in building wire and cables, air conditioner, power substations and automobiles. The average density of copper stock per area was 2.3 t/km^2 for the whole province, but it soared to 21.3 t/km^2 in Chengdu, the provincial capital of Sichuan. Chengdu's copper stock counted for 21% of total stock in the province, and the top five stock-containing prefectures took 47%. This study also demonstrates that the copper stock in prefectures has a strong linear relationship with the prefectural population and economic output.

Keywords: Copper, In-use stock, Provincial-level stock analysis, Bottom-up approach

Waste cooking oil-to-biodiesel: Simulating economic incentives for increasing the recovery rate in China

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Abstract:

Waste cooking oil (WCO) as a feedstock for biodiesel has advantages with respect to environment, energy and food security. Currently, the low recovery rate of WCO is the main concern in the development of China's biodiesel industry. The objective of this paper is to find out how different policy incentives influence catering enterprises' participation and willingness in WCO collection in China. We analyze the potential effects of providing incentives for participation in WCO collection by constructing two game models: a game model between the government and catering enterprises under the condition of information symmetry and information asymmetry and a Stackelberg game model among catering enterprises, recyclers, and biodiesel production enterprises. The game models show that proper incentives may help increase WCO collection more efficiently if they target catering enterprises instead of recyclers or biodiesel production enterprises. The simulation model suggests a correlation between policy incentives effectiveness and catering enterprises' sensitivity to collection prices of WCO. When the sensitivity degree equals to 3.15, a subsidy of 4000 Yuan / ton of WCO to catering enterprises is consistent with the effect of taking compulsory measures. When figure is between 0 and 3.15, it is more effective to take compulsory measures. When it is greater than 3.15, subsidy is recommended. To guarantee the effective operation of policy incentives, the support of law, policy guidelines and effective supervision must be provided.

Keywords: Incentive, Waste cooking oil (WCO), Game model, Participation willingness

Where has all the rice gone in China? Change in supply and demand balance and flow analysis of rice in China

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Abstract:

China is the world's largest producer and consumer of rice and therefore effective rice supply and demand estimates have significant impact on the national food security and reforms of the agricultural supply-side structure. Several domestic and international organizations track China's rice data on the supply side, and they are relatively consistent with each other; however, data on the demand side are scarce and often with high uncertainty. Chinese government does not publish official data on stocks for any types of grain. Consumption of grain is also rarely reported, and most of existing estimates are neither transparent nor consistent. The losses and waste at different stages along the grain supply chain are also poorly understood. These insufficient and controversial data have increased the unrealistic estimates of the supply and demand balance and lead to the biases and misjudgment in policymaking. First, this study estimates the amount of rice used at different stages of consumption (seed, feed, industry manufacturing and human food consumption) by the bottom-up material flow analysis (MFA). Then, this study presents the variability between data along the life cycle of rice, from paddy cultivation, postharvest handling, storage, transport, de-husking and milling, losses at all stages, to different segments of final uses from existing different sources. Based on a meta-analysis of various data sources, this study shows clear overview of the plausibility and consistency of existing estimates for China's rice supply and demand balance and improves rice estimates for mainland China. In particular, we focus on mass balance cross-check and aim to answer the question "where has all the rice gone" in the past several years through the data reconciliation. The publication of grain stock data is very important for food consumption forecasting and agricultural supply-side reform. Efforts should focus on improving accurate estimation on stocks or food use side would help reduce the balance uncertainty.

Keywords: Metal-analysis, Data reconciliation, Material flow analysis (MFA), China rice

Removal of inorganic in the non-metallic fractions of waste printed circuit board

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Abstract:

Recycling of Non-Metallic Fractions (NMFs) of waste printed circuit board is a hot and difficult point in resource recycling of electronic waste. In order to improve the reusing value of NMF, a new type of conical surface triboelectric system was used to separate NMF. The effects of feeding rate, rotating speed and plate voltage on the removal of inorganic were studied, respectively. Results show that the optimum separation performance could be achieved when the feed rate was 216 g/min, the inner cone speed was 500 r/min and the plate voltage was 50 kV. Under this condition, the Loss on Ignition(LOI) of positive plate product reached 85.12%, the yield was 23.81%. While the negative plate product LOI dropped to 59.22% with a yield of 36.45%. The scanning electron microscopy (SEM) image combined with X-ray fluorescence (XRF) analysis shows that SiO2, Al2O3 and residual metal in NMF could be effectively removed applying the triboelectric system as the inorganic is mainly distributed in the negative plate and organic mainly distributed in the positive plate. The above results show that this new triboelectric system is a simple process, which can effectively remove inorganic substances in NMF, and facilitate the subsequent reutilization of NMF.

Keywords: Waste printed circuit board, Non-metallic components, Triboelectric separation, Resource recycling

Revealing the environmental benefit of recyclable waste recycling

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Abstract:

With fast development and urbanization, Chinese cities faced multi-environmental challenges including issues of environmental pollution, climate change, resource depletion and also emerging landfill shortage problem. Waste recycling is an effective way to respond the multi-challenges. Therefore, this paper analyzed the energy saving and CO_2 reduction effect of recyclable waste recycling by taking the largest megacity Shanghai in China as a case study. Results showed that he energy saving and CO_2 reduction effect of existing recyclable waste recycling system in 2016 were 8.7 Mtce and 16.81Mt CO_2, respectively. Waste steel recycling and nonferrous metal recycling were the two dominant contributing factors, adding up to about 86% of energy saving and 93% of CO_2 reduction. The energy saving and CO_2 reduction potential were estimated to be 7.69 Mtce and 12.78 Mt CO_2, respectively, with about 80-85% from enhancing recycling rate and 10-15% from RPF technology. Moreover, the potential is mainly from further recycling of waste glass, waste plastic & paper, and waste steel. Finally, policies on speeding up the establishment of waste recycling system and promoting PRF technology are suggested.

Keywords: Recyclable wastes recycling, Embodied energy and carbon, Reduction potential, RPF

Impact of participation in global value chains on China's carbon emissions: A review

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Abstract:

The traditional inter-industry specialization and intra-industry specialization have gradually shifted into the product division of labor in a particular link or process, which has led to the restructuring of the global industrial system. This makes the resource and environmental conditions of countries in value chain links different. The big difference appears to have an important impact on the economy's carbon emissions. China is a big carbon emitter and faces enormous pressure on carbon reduction in the international community. At the same time, China is also an important participant in the global value chain, benefiting from economic benefits as well as carbon emissions. Finding out the impact of participating in global value chains on China's carbon emissions is very important for discussing how to share the responsibility for reducing carbon emissions scientifically and to reasonably promote international environmental governance. On the basis of summarizing existing literatures, this paper first sorts out the global value chain's impact on China's carbon emissions measurement methods. The methods are mainly divided into two types. One is to construct an economic carbon emission effect decomposition model which is integrated into the international division of labor, and to investigate the effect of global value chain effect on China's carbon emissions. The other is based on the input-output model to calculate the carbon emissions embodied in the value added trade, and to analyze the influence of the global value chain division on the implied carbon in China's foreign value added trade. Secondly, it summarizes the researches on the impact of carbon emissions in different industries such as Chinese industries, manufacturing industry and steel industry under global value chain. It is found that China's participation in the global value chain division has a negative impact on China's carbon emissions due to China's embedment at the low end of the global value chain. It is mainly reflected in the manufacturing sector with high carbon emissions, especially in the power and metal manufacturing sectors. Finally, based on this, this paper points out the research direction in the future: one, the research object from the participation in the global value chain on China's manufacturing carbon emissions expands to the service sector. The other, on the research method, from the use of input-output analysis to a combination of methods, such as input-output analysis and life cycle assessment combined to obtain more accurate and detailed results. Thirdly, the conclusion of the research extends from simply analyzing the impact of participating in the global value chain on China's carbon emissions to comparing it with the economic benefits (i.e., value added).

Keywords: Global value chain, Carbon emissions, China

High efficiency recovery of Eu from waste blue phosphors ($BaMgAl_{11}O_{19}$: Eu^{3+}) using a sodium peroxide system and its mechanism study

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Abstract:

An efficient process for recycling Eu from waste phosphors $BaMgAl_{11}O_{19}$: Eu^{3+} (BMA) has been developed. The treatment of waste blue phosphors by a sodium peroxide (Na_2O_2) molten salt calcining process was investigated. The results demonstrated that the calcination temperature and mass ratio of Na_2O_2 to waste phosphors have significant influences on the Eu extraction. More than 99% of Eu was recovered under the optimal conditions in terms of 400°C, 1:1 of Na_2O_2 to waste and 30min, respectively. The structure disintegration of the phosphor via alkali fusion is discussed. Sodium ions took priority of replacing the europium and barium ions in the mirror plane. The BMA transformed to be $BaCO_3$, Eu_2O_3 and another spinel structure $Na_2MgAl_{10}O_{17}$, which cannot be dissolved by HCl. With the increase of the alkaline melt temperature and time, the structure of $Na_2MgAl_{10}O_{17}$ was disrupted into MgO and $NaAlO_2$ gradually. The Eu_2O_3 can be recycled easily by washing, acid leaching, oxalic acid precipitation and calcination.

Keywords: Waste phosphors, Recovery, Alkali fusion, Mechanism

New resource efficiency indicator for better corporate engagement in Japan

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Abstract:

One of UN Sustainable Development Goals (SDGs) is to ensure sustainable consumption and production patterns aiming at “doing more and better with less”. A headline indicator of resource efficiency (RE) in terms of Gross Domestic Product divided by Direct Material Input (GDP/DMI) was introduced and monitored by Japan for years to track and impel her performance on decoupling the economic growth and resource use. However, this authorized economy-wide RE indicator is neither to include the upstream resource requirements for imports nor to differentiate changes of industrial sectors with various resource intensities. To overcome these shortcomings, we propose a sector-level RE indicator in terms of Value-added divided by induced Raw Material Equivalents of Input (VAj/RMIj) to represent sectoral resource efficiency in an economy. This RE indicator system can more fairly reflect the evolution of resource efficiency in different industries and incentivize better corporate engagement with endeavor to realize Japan’s master plan for a circular economy. As the empirical part, we harmonized the Japanese Input-Output (IO) tables and Material Flow Accounting (MFA) database from 1995 to 2011 to conduct an IO-based MFA analysis on temporal changes of RE by sector. The performances of the new and current RE indicators were compared to each other. Driving factors of temporal changes of RMI in Japan were further investigated by using Structural Decomposition Analysis (SDA). The key findings are as follows. (1) The national RE in Japan is improving by 2%/yr from 1995 to 2011, especially in electrical machinery industry and business to business (B2B) services in contrast to decreasing RE in manufacturing of plastics, metals and metal products, as well as gas and heat generation. (2) Performances of sectoral RE in terms of the new indicator are not necessarily changing the same as the current indicator, but both indicators confirm the worse RE in metal industry and power industry in Japan. (3) Decreasing VA share of material-intensive industries like construction and public works in the economy was found to be one of the most significant drivers to reduce the overall raw material equivalents in Japan during that period. This study demonstrates the consumption of non-metallic minerals was successfully diminished in Japan but it remains challenging to improve the profitable and efficient use of resources in metal and power industries.

Keywords: Resource efficiency, Sustainable consumption and production, Raw material equivalents, Input-output analysis, Material flow accounting, Structural decomposition analysis, Circular economy

Impacts of industrial structure on energy consumption and carbon emission changes across space and time: A case study of Beijing, China

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Abstract:

For the past decades, China has undergone rapid urbanization and socioeconomic development. This transformation has led to accompanied increase in energy demand and subsequent greenhouse gas emission. Economic growth and urbanization are highly correlated with energy use and GHG emissions levels. In 2014, CO_2 emission in China reached 10 billion tons, with a 29% share in the global total emissions.

Recently, the Paris Agreement (2015) has drawn attention to the dramatic actions necessary to reduce carbon emissions, and China has submitted its Intended Nationally Determined Contributions (INDC). China has entered a new stage of sustainable transformation, during which mitigation polices are urgently needed to promote industrial transformation and green economic development to improve emission reduction, especially in metropolitan regions. However, application of mitigation policy for low carbon societies is complicated, which should take the unique regional development conditions (socially, physically, economically and politically) into consideration. In this study, taking Beijing metropolitan region as case study area, we aim to build up historical sub-city energy use and carbon emission inventories, and further to analyze the socio-economic, political and institutional and biophysical factors (especially industrial structure) that explain the variations in these conditions across space and time. The results will be of significance to mitigation policy making and application for low carbon city development.

Keywords: Industrial structure, Energy consumption, Carbon emission, Beijing

Analysis of waste management's influencing factors at municipal recycling facility in Bandung, Indonesia

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Abstract:

Waste recycling will be effective when it starts from the source. As it is difficult to control waste recycling at individual waste generators, the city government of Bandung facilitates recycling activities in several collection points. However, only a few sites which show sustained recycling activities. Therefore, research was conducted to assess and determine the factors affecting the Municipal Recycling Facilities. Data were obtained through questionnaires and interviews of recycling managers and communities. The study area consists of municipal recycling facility at Babakan Sari at which represents a sustained facilities and municipal recycling facility at Cicadas at which represents a non- sustained recycling facilities. A logistics regression was used to determine the influencing factors within technical, funding, institutional, regulation and community participation aspects. The regression shows that the storage system, the existence of skilled operators, the existence of private investment/NGO, the existence of operational cost from the government, the formation of community institution, the involvement of the people in processing and the frequency of the meeting are the significant influencing factors.

Keywords: Collection point, Municipal recycling facilities, Recycling

Justice perception measure and interest coordination of stakeholders of sustainable supply chain in inter-basin water transfer project

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Abstract:

There are many stakeholders in the sustainable supply chain of inter-basin water transfer project, due to the “divide and conquer” management in the operation, lead to imperfect interest coordination mechanism between the stakeholders, there is not enough attention on stakeholders’ justice perceptions and cause some mass incidents and do great threat on the regional ecological security, social stability and economic development. Therefore, it is necessary to consider the justice perception of stakeholders in inter-basin water transfer project, so as to realize the sustainable supply chain coordination mechanism of inter-basin water transfer project for economic, social and environmental aspects.

Firstly, this paper identifies and classifies the multi-dimensional elements, investigates relevant stakeholders and studies relative information. Secondly, this paper studies the measurement model for justice perceptions of stakeholders and the emergence of justice perceptions and the mechanism of cooperative behavior under the justice perception in the sustainable supply chain of inter-basin water transfer project. Thirdly, this paper measures procedural justice, interactive justice and distributive justice of stakeholders from the three aspects of environment, society and economy. And then, we use the field survey and in-depth interviews, evolutionary game theory and some other scientific methods to study the mechanism of individual justice perceptions to the entire group of immigrants and residents living along the route, moving along the enterprise of inter-basin water transfer project, so as to study the mechanism of cooperative behavior of stakeholders in the inter-basin water transfer project sustainable supply chain. Finally, based on the above research, this paper designs an effective coordination mechanism to maintain the stability of stakeholder cooperation and realize the sustainability of the inter-basin water transfer project supply chain.

Keywords: Inter-basin water transfer project, Sustainable supply chain, Justice perception, Interest coordination

What makes consumers in the UK and Germany choose the ethical alternative of a food item - genuine concern or warm glow?

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Abstract:

The share of the sale of food products meeting ethical standards continues to be a fraction of total food product sales, even in countries with well-developed markets for ethical food products, and even despite the fact of overall positive attitudes towards these standards and their respective social or environmental goals. What are the underlying latent forces behind the demand for food items with ethical claims? We conducted a representative survey of consumers in the UK and in Germany in order to identify those factors.

The offset of the survey marked a Choice-based Conjoint (CBC) analysis making respondents choose among chocolate bars with varying labels: fair trade, organic, carbon neutral and none. Other product attributes included price, origin of cocoa and country of manufacture. Thereafter, respondents answered a diverse field of questions about their preferences of time and place, values, warm glow of giving and knowledge of the respective labels. The data for both samples has been collected and is been analyzed currently.

The question we intend to answer with the results of our survey is, whether it is genuine concern or the warm glow of giving that leads consumers to choose the ethical alternative of a food item. The genuine concern is captured by the preferences of time and place respondents portray in their answers. Those preferences are explored with the help of a principal component analysis. It is assumed that those preferences are correlated with the value priorities of respondents; e.g. respondents with a low time preference and a high consideration for consequences in distant places would give the value ‘universalism’ high priority. If these consumers derive a high utility from ethically labeled products, a case of genuine concern is hypothesized. Consumers that also opt to choose the ethically labeled product, but do not show a consistency within these indicators of genuine concern, but rather with our items of warm glow of giving, are assumed to purchase ethically labeled food items due to rather egoistic than altruistic reasons. Hereby, we enlist ethical food items in the category of impure common goods.

Based on structural equation modelling, the varying degrees of influence of genuine concern and warm glow on the valuation of utility of ethically labeled food items by the consumers are to be tested. Additionally, we expect to observe differences between the country samples.

The newly gained insights could be utilized when designing marketing strategies or

public policies in order to foster an increased consumption of ethically labeled food products.

At the conference, we would present the results of our research.

Keywords: Ethical labels, Food products with ethical claims, Choice experiment, Warm glow, Fair trade, Organic, Carbon-neutral, Consumer preferences, Cross-cultural

Theory about input-output analysis: Some properties of Leontief inverse matrix and Ghosh inverse matrix

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Abstract:

It is well known that the environmental input-output analysis plays an important role in the industrial ecology, and that the core of the environmental input-output analysis is the input-output model. Therefore, to research on input-output analysis is essential for industrial ecology.

There are two groups of matrices in input-output analysis, one group is the monetary intermediate input coefficients matrix, the intermediate output coefficients matrix, and the physical intermediate input coefficients matrix, and the other group corresponding to the above-mentioned three matrices respectively is the Leontief inverse matrix in value terms, the Ghosh inverse matrix, and the physical Leontief inverse matrix. In this paper, we further reveal a fundamental property on row elements of the Leontief inverse matrix in value terms and a fundamental property on column elements of the Ghosh inverse matrix. Meanwhile, we extend the property on 2×2 submatrix of the Leontief inverse matrix in value terms to the Ghosh inverse matrix and to the physical Leontief inverse matrix. These properties play a crucial role to the study of the effects of changes in outputs and in prices on the economic system.

In detail, Zeng (2008) has proved that in the Leontief inverse matrix in value terms, each row entry is less than or equal to the main diagonal entry of this row, and that in the Ghosh inverse matrix, each column entry is less than or equal to the main diagonal entry of this column. In this paper, we prove that if the row vector of values-added rates is positive, then in the Leontief inverse matrix in value terms each row entry is less than the main diagonal entry of this row. We prove that if the column vector of final output rates is positive, then in the Ghosh inverse matrix each column entry is less than the main diagonal entry of this column. After we arbitrarily choose a submatrix of order 2 in the Leontief inverse matrix in value terms, Zeng (2001) has proved that, if a main diagonal element in the submatrix is a main diagonal element in the Leontief inverse matrix in value terms, then the determinant of the submatrix is non-negative. In particular, if the two main diagonal elements in the submatrix are all the main diagonal elements in the Leontief inverse matrix in value terms, then the determinant of the submatrix is greater than or equal to 1. According to the relationship between the Ghosh inverse matrix and the Leontief inverse matrix in value terms, we prove the Ghosh inverse matrix has this property on submatrix. According to the relationship between the physical Leontief inverse matrix and the Leontief inverse matrix in value terms, we prove the physical Leontief inverse matrix also has this property on submatrix.

Keywords: Input-output analysis, Leontief inverse matrix, Ghosh inverse matrix

Research on the optimization of China's industrial institutions under emission reduction targets --- based on input-output analysis model and multiobjective programming model

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Abstract:

According to the Paris agreement, the global average temperature rise is controlled within the 2℃ of pre-industrialization, striving for no more than 1.5℃. In response to climate change, the countries of the word have formulated their own contribution to reduce emissions. China has pledged to reduce its carbon dioxide emissions by 2030 percent of GDP by 60% to 65% from 2005. As a reduction target, this paper uses input-output analysis model to calculate the relationship between economic and carbon emission correlation in 27 industries in China. Based on the differences between the two associations, to select industry groups that need to restrict development and need to encourage development. And then, using Multi-objective programming model to set different scenarios, to simulate and analyze the industrial structure of China in 2030. And calculate the size of the contribution of industrial structure adjustment to emission reduction. The simulation results show that: Adopting differentiated industrial structure adjustment policies based on a comprehensive weighing of carbon emission correlation and economic correlation, China can keep its total investment unchanged in the future while achieving the dual goal of reducing carbon emissions and sustaining economic growth. According to the situation analysis, the greater the intensity of industrial structure adjustment, the greater the future carbon emission reduction and GDP increase. Therefore, it is necessary to make overall consideration of the relationship between industry economic and carbon emissions to adjust the industrial institutions. Thus to maximize the contribution of emission reduction and to achieve our own contribution.

Keywords: Carbon emission, Industrial structure optimization, Input-output analysis model, Multi-objective programming model

Predicting the spatio-temporal environmental impacts of iron ore production by linking geometallurgy and life cycle analysis

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Abstract:

The efficient extraction and processing of metals is an important feature of resource sustainability. Geometallurgy is a cross-disciplinary approach incorporating geological, mining and mineral processing information to provide a model for production planning. It is used to optimise the mine plan and the circuit design for mineral processing. The data used in and generated by the geometallurgical study can be used to calculate the environmental impacts of a project on a spatial scale within the pit and/or on a temporal scale throughout the mine life using a life cycle assessment (LCA) approach.

Most of the sustainability and energy efficiency dimensions of geometallurgy are driven by mineralogy. Geometallurgy provides a way to map the spatial variations in the mineralogy of the ore body which in turn can provide information about how these variations will influence equipment requirements, dependency rules, and processing performance. The approach also considers the best opportunities for future impact reduction. This data can be used to calculate energy and material consumption for the extraction and processing of ore and used as the life cycle inventory data to generate a spatio-temporal life cycle impact assessment (LCIA) for metal production.

Using data generated from the LCA, it is possible to create a block model with environmental performance information replacing mineralogical or grade data. This allows for the novel approach of scheduling the mining and processing of a deposit based on environmental criteria. This environmental performance data can then be used as a tool for design and optimisation of a project with environmental performance in mind.

A case study is presented for Carajas Iron ore mine, Brazil. A 3D block model was created using Datamine Studio OP and was scheduled for production using Datamine NPV Scheduler according production, engineering, and economic constraints, maximising Net Present Value. Data generated from the block model and schedule along with mineralogical data was used in the life cycle inventory during the LCA which was completed using GaBi software.

Keywords: Life cycle assessment, Geometallurgy, Resource efficiency, Environmental impacts, Resource management

How biomass can be applied as reliable energy for power generation: A case study of Nova Scotia Power in Canada

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Abstract:

Canada as one of the highest country in terms of greenhouse gas (GHG) emission per capital around the world, committed to the world that she would reduce GHG emissions significantly in the following 15 years. Therefore, renewable energy in lieu of the traditional fossil energy can be considered as the effective solution. Among the renewable energy like solar energy, wind energy, tidal energy etc., biomass is also considered alternative renewable energy. At Cape Breton city in Nova Scotia province, where it is located in the east in Canada, the biomass energy has been applied as the renewable energy in lieu of amount of coal for the power generation. However, the technical issue and economic risk is deserved to be investigated. Therefore, this study aims to investigate the background and motive of this biomass development in this area, the implemented strategy and policy, as well as the potential technical issue and economic risks.

Keywords: Biomass, Renewable energy, Power plant, Canada

The dynamics of household appliances in urban dwellings: A spatial explicit analysis in Beijing, China

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Abstract:

The rapid urbanization in China is unprecedented in terms of both speed and scale during the past three decades. China has been one of the most populous countries in the world with more than half of its population now living in cities. Huge demands of household appliances for fulfilling people's living have resulted the increasing need for materials and energy and lead to a number of environmental problems. The aim of this study is to quantify the stocks of household appliances in Beijing's dwellings using a spatial explicit model from 1980 to 2015. A model integrating bottom-up method and geographic information system (GIS) was developed to quantify the stocks of household appliances at a high spatial resolution of 100×100 meters. Total stocks of household appliances in each building, including television, air condition, computer, refrigerator, and washer, were calculated by the number of apartments in each building and ownership per household. Then, we summed them up in GIS and quantified spatiotemporal patterns at community, district, and city levels. We also conducted a sensitivity analysis by altering each parameter in the model individually and then evaluated their total effects on results. The limitations of the model both in structure and input data were discussed at last. The results of our study should be useful for designing effective policies for city management and sustainable development by explicitly recognizing major stocks and flows of household appliances.

Keywords: Material stocks analysis, Spatial study, Products, Geographic information system, Bottom-up approach

Scenarios for energy use and GHG emissions of China's future aluminum cycle

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Abstract:

China is currently the largest producer and consumer of aluminum in the world. An increase in demand for aluminum caused by rapid growth of consumption for in-use stocks leads to huge pressures on energy and environment of the world. To examine future GHG emission patterns of China's aluminum cycle, a stock-driven approach has been used to estimate scenarios of future aluminum stocks and flows until 2100. These scenarios were used to predict the energy use and GHG emissions embodied in each aluminum life cycle process with multiple key parameters, including peak and growth rates of in-use stock per capita, lifespan distribution, net imports and loss in the cycle. Direct, indirect, and process emissions are all included. The major findings are as follows: (1) under all scenarios, China will continue to build up in-use stocks mainly from primary aluminum, but China's in-use stocks will become mature and eventually stabilized in this period, which will provide opportunities for urban mining and emissions reduction through recycling; (2) low stock saturation scenario, based on the optimistic assumptions for recycling rates and new technology penetration, has the highest reduction potential in GHG emissions, followed by middle stock saturation scenario and high stock saturation scenario; (3) under the high scenario in which the peak value of aluminum in-use stock per capita in China reaches the mean value of the U.S. and Japan, China's demand for primary aluminum will reach its maximum around the year 2022, and GHG emissions from China's aluminum cycle will also reach the summit. Several adaptations, including lowering peak of in-use stock per capita, prolonging lifespans of products, and reducing net exports as well as loss, can effectively reduce the demand of primary aluminum in the future, thus alleviating the GHG emissions caused by aluminum industry.

Keywords: Aluminum cycle, In-use stocks, GHG emissions, Scenarios, Dynamic model

Analysis of approaches and effects of energy saving and consumption reduction in a typical large municipal sewage treatment plant in Beijing

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Abstract:

As an important support of public utilities, the green operation of municipal sewage treatment plant has become a necessary condition for the construction of the resource-saving and environment-friendly society. At the same time, sewage treatment is a relatively concentrated resource and energy industry, so energy saving and consumption reduction is particularly important. The main ways of energy conservation are: the overall energy saving strategy, the optimized operation of equipment, the comprehensive utilization of biogas and the utilization of waste heat. The main ways to reduce consumption are the decrease of fresh water and medicament consumption. A research about energy saving and consumption reduction was carried out in a large Beijing municipal sewage treatment plant, and the results showed that: by updating the variable frequency feed pump, the optimized operation of sand, aeration and sludge discharge system and the precise control of chemical phosphorus removal, the efficiency of energy saving and reducing consumption was remarkable. The power consumption was reduced by 5.47%, aluminum sulfate consumption was reduced by 28.4%, flocculant PAM consumption was reduced by 7.3%. Only from the cost of electricity and drug consumption, the cost of unit sewage treatment could be reduced by 0.041 yuan/m3. Meanwhile, the reduction of energy consumption, such as electricity, could effectively reduce greenhouse gas emissions from the source, and the reduction of the amount of phosphorus removal chemicals could also reduce the production of chemical sludge. The way of saving energy and reducing consumption in the sewage treatment plant can be used for reference for the operation of other municipal wastewater treatment plants in Beijing or other sewage treatment plants in the country.

Keywords: Municipal sewage treatment plant, Energy saving, Consumption reduction, Economic benefit, Environmental benefit

Balancing the supply and demand of food, energy and water in urbans: A nexus approach

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Abstract:

Food, energy, and water (FEW) are inextricably interrelated having significant correlations and tradeoffs along with the three resources' production and consumption, namely the FEW-Nexus. The importance of FEW securities for sustainable urban development has been globally acknowledged, and great attentions have been paid to secure city-scale FEW supply provisions. Comparatively, endeavors about balancing the three resources' supply and demand are relatively rare. In this study we conduct process modeling for each FEW subsystem, and established an integrated FEW nexus framework to simulate the resources' supply and demand in urban contexts. To harmonize the supply and demand of FEW resources and maximize urbans' economic growth, we developed an optimization algorithm to address the tradeoffs and conflicts associated with urban FEW governance. Sensitivity analysis was employed to identify the driven factors and critical determinants for sustainable FEW nexus of urbans. The city of Zhangjiakou was used for case study to illustrate the advantages of the proposed methodology in modeling FEW nexus, understanding FEW interactions, as well as optimizing the FEW supply and demand to advance sustainable city management moving forward.

Keywords: FEW nexus, Urban, Process modeling, Supply-demand optimization

Empirical analysis of national power portfolio for positive environmental implications of electric vehicles

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Abstract:

It is admitted that EV can be better for sustainable future; however, the hot spot of EV is the source of electric power, which can determine the environmental implications of EV. The purpose of this study is to evaluate the environmental implications of EV in South Korea considering the current power production portfolio and the future road map for power supply. The electricity production in South Korea depends on bituminous coal thermal power generation (46%) and nuclear power (38%) in 2015. We conducted life cycle assessment (LCA) to evaluate environmental impact of domestic power generation of 1kWh using life cycle inventory provided Korea Environmental Industry & Technology Institute (KEITI). A large amount of carbon dioxide was emitted in the steam power generation based on coal fuel such as anthracite coal, bituminous coal, heavy oil, and LNG, 1.361, 1.158, 0.805, 0.458 kg CO_2 equivalents per 1kWh, respectively. As a result of normalization and weighting using various factors provided by the Ministry of Trade, Industry and Energy, the environmental impact of pumping hydro generation is 1.965E-01 per 1kWh, which has the greatest environmental impact. Then, the environmental impacts were analyzed in the order of bituminous coal steam power, nuclear power, heavy oil steam power, and anthracite coal steam power.

Keywords: Power generation, Life cycle assessment, Electric vehicle, Environmental impact

Effect of solvent on activity of modified Calb in production of biodiesel from waste animal fat

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Abstract:

Enzymatic reaction is an efficient option for the production of biodiesel from waste oil and fats because it can utilize high content of free fatty acids in feedstock without pretreatment. However, the price of enzyme is still high compared with chemical catalysts used in commercial process, therefore, the lifetime of enzyme is an important factor to determine the economic feasibility of enzymatic process. The activity of enzyme can be affected by many factors such as methanol feeding mode, glycerol accumulation and impurities in feedstock. In this study, the feasibility of solvent addition to preserve the activity of modified CalB in production of biodiesel from waste fat was investigated. Several organic solvents and supercritical CO2 were applied and the changes in enzyme activity were compared. In addition, the process modification to enhance the lifetime of CalB in a packed-bed reactor was performed.

Keywords: Biodiesel production, Enzymatic reaction, Waste oil and fat, Effect of solvent, Supercritical CO_2

Calculation of waste recycling in China and analysis of its driving factors

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Abstract:

Since the almost last forty years of reform and opening up, China's economy has experienced a sustained and rapid growth to become the second largest economy in the world. In the past, the relatively extensive economic development model resulted in low resource utilization and a large amount of waste. As early as 2011, China's urban household garbage production was about 277 million tons, which is the largest garbage country, accounting for about 26% of the world's garbage. In 2011, there were only 164 million tons of garbage in China, and other waste disposal methods were generally piled up in the open air, which seriously polluted the atmosphere, soil and water environment. while few people know the socio-economic factors that drive the growth of waste recycling.

This paper is based on the input and output table of China from 2000 to 2015,and through structural decomposition analysis (SDA) method to analyze the six factors including waste recycled strength, technology level, the final demand structure, the structure of the GDP, per capita GDP and population which influence the recycling of five kinds of waste (iron and steel scrap, scrap non-ferrous metals, waste plastics, waste paper, waste rubber); From the final demand perspective to analyze the impact of six different categories of final demand including rural residential consumption, urban residential consumption, government consumption, gross fixed capital formation on the waste recycling. In addition, the waste recycling is analyzed from the industry level. Combining the IO-SDA model with the scenario hypothesis method to predict the recycling amount of certain types of waste in 2020, Analyzing the key drivers of specific waste recycling in 2020, It will put forward reasonable policy Suggestions for improving the recycling rate of waste and promoting the conservation of resources. This systematic research on the social and economic driving force of China's waste recycling is the key to guide policy-making and technical development goals.

Keywords: Waste recycling, IO-SDA model, Key drivers of waste recycling, Conservation of resources

A comparative analysis of the effect of environmental improvement on drone-based delivery system in urban and rural areas

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Abstract:

In rural areas, relatively low population densities and long delivery distances compared to urban areas make it difficult to deliver goods using traditional vehicles such as trucks and motorcycles. Unmanned aerial vehicles (UAV, drone) used for delivery purposes have received increasing attention due to their mobility and accessibility to remote areas. The purpose of this study is to evaluate the effect of environmental improvement of the new drone-based delivery system as well as motorcycle delivery, and to compare the expected effect of environmental improvement to urban and rural areas by introducing a drone delivery system. Furthermore, the potential environmental impacts of introducing new vehicles, such as electric motorcycles, and the change of power generation systems was assessed. Life-Cycle Assessment (LCA) was used to analyze the transportation phase of pizza delivery from the producer to the consumer. The results of this study are as follows; (1) GWP per 1km of drone delivery was one-sixth that of motorcycle delivery, and the particulate matter produced was half that of motorcycle delivery; (2) the expected effect of environmental improvement from drone delivery is 13 times higher than that in urban area; the effect of environmental improvement resulting from the implementation of a drone delivery system will increase as the use of environmentally friendly power generation systems, such as solar and wind, increases.

Keywords: Unmanned aerial vehicles, Effect of environmental improvement, Life-cycle assessment, Delivery system

Challenges towards carbon dioxide emission peak under in-depth socioeconomic transition in China: Insights from Shanghai city

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Abstract:

Reaching the CO_2 emission peak before 2030 is a challenging task for China, especially the country is under rapid economic growth and moving towards an in-depth socioeconomic transition stage. While China as a whole is still fighting with reversing the CO_2 emission growth, several well-off cities in China show the tendency to cap their CO_2 emissions. This study took Shanghai, the front runner in China's socioeconomic transitions and CO_2 emission peak, as a case study to explore the emission peak stages from a socioeconomic transitions perspective and identify the key opportunities and challenges for China's CO_2 emission mitigation during the transition process.

Results show that while the production-based emissions of Shanghai have stopped growing around 2007-2008, CO_2 emissions considering its electricity purchase and consumption-based emissions still present strong expanding trend, indicating the obvious emission stages under three different accounting scopes. From the view of industrialization from an industrial base to a modern service center in Shanghai, changes in production/demand structure and import/export structure led great variation to Shanghai's CO_2 emissions. Resources related industry is the main industry curbing emissions, and it help Shanghai avoided 383.5 Mt emissions by outsourcing resources related products from 2000 to 2012; the booming service industry added 117.2 Mt CO_2 emissions for Shanghai in 2012, compared to 36.6 Mt in 2000; also, the high-tech industry and transport equipment industry also generated 47.7 Mt and 40.0 Mt CO_2 emission, respectively, during 2000-2012. From the view of the transition from production-oriented to consumption-oriented economy, CO_2 emissions embodied in urban household consumption increased from 47.3 Mt in 2002 to 90.8 Mt in 2012. Moreover, urban household consumption also showed a trend of shifting from consumption of materials to consumption of services, and citizens' growing consumption on recreation, culture, commerce and other services add 28.2 Mt CO_2 for Shanghai emissions in 2012. This booming urban consumption further boosted Shanghai's consumption-based emissions by soaring material and service import and investment in construction. Shanghai's case shows the in-depth socioeconomic transitions towards a services and consumption dominated economy and society brings China new opportunities and challenges to CO_2 emission peak.

Keywords: Carbon dioxide emissions, Socioeconomic transition, Input-output analysis

Study on surface water environmental impact assessment in shale gas development

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Abstract:

In order to analyze the impact of shale gas development on surface water environment, based on domestic and overseas shale gas production environmental properties, theoretical analysis method and frequency analysis method are applied to screen common indicators and characteristic indicators of surface water pollution risks assessment in shale gas production. Given the above study, a comprehensive surface water environmental impact assessment index system for shale gas development is set up. Analysis shows that drilling stage, hydraulic fracturing stage, production and processing stage are considered as the key links to pollution-producing processes. In these stages, drilling wastewater, fracturing flowbacks wastewater and domestic sewage are the main pollution sources.17 common assessment indexes and 9 characteristic assessment indexes are screened for impact assessment of shale gas development on surface water environment. Industrial wastewater up-to-standard discharge rate, industrial wastewater reuse rate, industrial wastewater treatment rate and surface water environment quality indicators (COD, pH, ammonia, suspended solids, petroleum and etc.) present higher frequency rate according to hundreds of related literatures and data and therefore are selected as the main common assessment indexes. By analyzing the main pollution-producing stages and water quality and water quantity monitoring indictors, drilling fluids recovery and utilization rate, drilling fluids treatment rate, fracturing fluids flowback rate, flowback fluids recovery and utilization rate, flowback fluids treatment rate, and characteristic pollution sources water quality monitoring indicators (TDS, metal ions, chloride and radioactive substance) are selected as the characteristic assessment indexes. The construction of this assessment index system can provide a basis for surface water environmental management in shale gas exploitation.

Keywords: Shale gas development, Surface water environment, Pollution-producing stage, Assessment index

Evaluation for sustainability of limited land resources in Jeju Island using ecological footprint model

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Abstract:

Since the Jeju Island in South Korea has established the Jeju Free International City Plan, it has increased the land use by reforming urban planning and attracting large projects for tourism purposes. However, Jeju Island has limited available area due to the local characteristic of isolated region. Considering the limited use of land resources, it is necessary to evaluate environmentally required land for sustainable Jeju. The goal of this study is to analyze the human, social and environmental situation of Jeju Island and to evaluate the environmental capacity of land use using ecological footprint (EF) model for sustainability of Jeju. Also, we evaluate ecological deficit reflecting the characteristics of Jeju and try to suggest management policies and alternatives. The categories for estimating total EF consists of food land (arable land, pasture), built-up land, forest, and energy land. In order to reflect characteristics of Jeju, it is conducted considering the tourist and the EF of forest. The outputs of this study could provide excess environmental capacity in the land sector through comparison EF and ecological productive land (EPL) for preparing a plan to management land use.

Keywords: Ecological footprint, Land use, Ecological productive land, Island, Environmental capacity

Research and application status of dynamic life cycle assessment

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Abstract:

Life cycle assessment (LCA) aims to track and quantitatively analyze and evaluate of environmental impacts, energy and resource efficiency during the whole process of product's initial raw material extraction, raw material production, product manufacturing, product use and product post-processing. But the static life cycle assessment results are inaccuracy and uncertainty because the future development will enable a further reduction of consumption of resource and energy. Different factors are responsible for this development, such as progress with respect to energy system and production technical, in particular, improved efficiency, increased lifetime, etc.

Dynamic life cycle assessment (DLCA) is the evaluation method of dynamic process modeling for the temporal and spatial changes of the surrounding industrial and environmental systems. Through the application of DLCA, the sensitivity and accuracy of the analysis results can be improved, which is suitable for the impact assessment of complex systems. Dynamic life cycle assessment can also enable decision-makers to understand the real time performance of products in the life cycle when they are changing in temporal and spatial, and make decisions in time to minimize environmental impact.

This paper reviews the current research and application of dynamic life cycle assessment, including the dynamic modeling of LCA, extraction of dynamic data, and dynamic evaluation of influencing categories. At present, the dynamic modeling is built mainly based on the developing of the energy system and technology, the dynamic changes of construction and building materials, sewage treatment technology and new energy automobile; The dynamic data extraction is due to the consideration of monitoring of energy consumption in the manufacturing process or the discharge of pollutants in real-time; The dynamic evaluation of impact categories established by Levasseur et al for the evaluation of global warming that calculated by dynamic characteristic factors. Then it was used to evaluate greenhouse gas mitigation benefits of temporary carbon sequestration projects caused by land use, land use change and afforestation and to evaluate the environmental impact of replacing fossil fuels with biomass-based fuels. Besides, the impact of Photochemical oxides was evaluated with a monthly dynamic characteristic factor. This paper also summarizes current challenges and opportunities for the improvement of the DLCA.

Keywords: LCA, Dynamic modeling, Dynamic data, Dynamic evaluation of impact categories

PM2.5 emission reduction in energy field of Beijing-Tianjin-Hebei region in 2030

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Abstract:

The Beijing-Tianjin-Hebei region is an important region of China with fast economic development and large population, but it is the most serious air pollution area in China. In order to achieve the goal of beautiful China, the government is taking measurements to protect the ecological environment, and the air quality in the Beijing-Tianjin-Hebei region has been improved significantly. For example, in 2017, the cumulative concentration of PM2.5 in Beijing was 58ug/m^3, decreasing about 35.8% compared to 2013. In future, the strict air pollution control policy and advanced technique could be implemented in this region. Based on the regional development strategy, energy conservation and emission reduction policies, this study builds an integrated LEAP-Region model to comprehensively evaluate the future energy consumption of the Beijing-Tianjin-Hebei region, PM2.5 emission intensity and its health benefits. We expect to be able to assess the health benefits of the energy adjustment strategy, and propose measures to regulate the energy consumption structure and reduce the emission of air pollutants from the perspective of protecting the health of residents. Finally, the corresponding countermeasures and suggestions are put forward.

Keywords: PM2.5, Energy, Beijing-Tianjin-Hebei region, LEAP model, Health impact

Pathway of subway development and construction materials stock in Chinese cities

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Abstract:

Rapid urbanization in China has significantly altered the material and energy stocks and flows in Chinese urban transportation systems. Among other fast developing transportation infrastructure, subway system involves as an excellent example of urban expansion and socioeconomic growth. Quantifying the changing metabolic patterns of the urban subway system could help inform urban decarbonization and dematerialization strategies. This paper conducted a material stock analysis of the subways in 30 major cities in China, and explored their driving factors (e.g., GDP, population, urbanization rate, and built-up area) behind from 1971 to 2017. The results showed that the changes of material stocks in Chinese urban subway systems experienced a moderate and steady growth before 2008 and a rapidly enhancement afterwards. The total length of the entire subway system reached 4,400 km and the embodied construction material stocks amounted to 7,500 million tons, of which Shanghai ranks the first and accounts for almost one seventh. These findings could not only provide corresponding evidence of overwhelming subway construction and thus construction materials and waste management challenges in the coming decades in China, but also shed light on sustainable urban transportation development in other developing cities and countries.

Keywords: Subway system, Materials stock, Sustainable development, Chinese cities

Operation mode and main characteristics of the deposit-refund system based on the extended producer responsibility and stakeholder theory

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Abstract:

The generation of waste has increased proportionally across the world. How to realize the waste collection and resources recycling is a problem that facing all countries in the world. Most informal collection also brought serious environmental and safety problems in the existing recycling system. It is high time to establish an effective long-term mechanism for waste collection and recycling. As an effective means to realize the extended producer responsibility, the deposit-refund system is also an effective low-cost economic means for renewable resource collection and recycling. It is an economic incentive method to internalize the external non-economy in environmental protection management. which fully embodies "who pollutes, who pays, who governs, who benefits". The deposit-refund system was implemented by Sweden, Germany, Denmark and other countries in the 1980s. Accompanied by the success of the implementation in the beverage packaging industry, the deposit-refund system gradually extended to automobiles, old tires, empty bottles and waste recycling batteries, pesticides. This paper compares the Germany, Sweden, Norway, the United States and other countries of the deposit-refund systems from the following aspects: development background, stakeholder responsibility, scope of application, the deposit payment process, the fund mechanism in the system operation. The results show that there are some common problems in the implementation of the deposit-refund system in spite of the difference in the operating mechanism of the deposit recovery system of different kinds of waste in different countries, these barriers are government policies, consumer attitude, technological gaps, stakeholders' role, globalization and economic consideration between formal and informal sector. Then this paper prospects the deposit-refund system development direction in the field of recycling of waste: reasonable definition scope of the deposit-refund system; appropriately determine the stakeholder roles and responsibilities; dig into the value of potential information.

Keywords: Deposit-refund system, Extended producer responsibility, Stakeholder theory

Water-food-energy nexus from the perspective of China's inter-regional spillover and feedback effect: A supply driven input-output approach

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Abstract:

The concerns about water, food, and energy, based on sustainable consumption and production, are now a global priority. Because of the close linkages between water, food and energy, a nexus approach has been one of the research hotspots in recent years. China, as one of the biggest consumers of water, food and energy, its challenges on securing sufficient water, food, and energy supplies to meet the demand are amplifying. Given that, this study proposed an inter-regional input–output analysis to provide a unified framework to explore the water-food-energy nexus for Primary Industry, Secondary Industry and Tertiary Industry in China during 2007 to 2012. Based on the most recent IRIO table in China (not including Tibet, Hong Kong, Macao and Taiwan), we combined 30 sectors and 30 regions into three industries and seven regions. An IRIO analysis techniques was used to investigate the interaction between the water, food and energy impacts of products in different industries from the perspective of inter-regional spillover and feedback effect. This study is devoted to the comprehensive analysis of the internal relations of water-food-energy, trying to find the optimal balance range to reduce the consumption of water-food-energy system. The results identified industry sectors and regions with high consumption of water-food-energy system and analyzed the common and key factors which promote the system and put forward policy implication. This study recognized that transformative social change is needed to create new industrial structures, markets and trading pattern to deal with the nexus based on the sustainable development goals. This study may also help identify the leverage points and regulating pathways of water-food-energy system and provide a better way for mitigating the resources and environmental pressure in China.

Keywords: Water-food-energy nexus, Inter-regional input-output analysis, Spillover and feedback effect, China

The potential of waste resin powder for wood–plastic composites

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Abstract:

With the large amount of production and use of electrical and electronic products, the industry of printed circuit board manufacturing is booming. More than 2800 printed circuit board manufacturers in the world producing a large amount of waste resin powder every year. If the waste resin powder is not properly treated, it will pose a great threat to the environment and human health. At the same time, traditional incineration and landfill disposal methods have brought great environmental pollution and waste of resources. It is the general trend to solve the problem of waste resin powder treatment by the way of resource circulation. Recent studies have demonstrated the waste resin powder as filler and performance reinforced material in wood–plastic composites (WPCs). The objectives of this research were to determine the impact of waste resin powder on the development of WPCs properties. Determine the optimum ratio of raw materials and additives such as waste resin powder, high density polyethylene, wood powder and compatibilizer through experiments. The results show that the intensity and hardness of the wood plastic composite can be greatly improved by the waste resin powder, but the flexural properties are reduced to a certain extent. Increasing the waste resin powder produced increasingly positive impacts on water absorption and thickness swelling. The economy and properties of PCBs reached the best when the proportion of waste resin powder, HDPE, wood powder and coupling agent were 40%, 34%, 22% and 4%.

Keywords: Waste resin powder, Wood–plastic composites, Material properties, Resources circular

Analysis of factors driving climate adaptation behaviour based on an extended protection motivation theory model

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Abstract:

In recent years, many changes in climate have led to plenty of adverse impacts on social-economic system and ecosystem. In response to climate change, countries all over the world have taken various policies and measures to reduce greenhouse gas emissions to abate the further rising of global average temperatures. However, researchers noted that further warming is unavoidable even if carbon dioxide emissions were to cease henceforth. Therefore, no matter whether people make urgent efforts in reducing emissions, to cope with climate change risk, and weaken the existing adverse effects of climate change, adaptation is inevitable. For households, adaptation behaviour is vital to reduce individual welfare losses. Many studies in recent years have estimated the factors that influence the uptake of climate change adaptation behaviour, with much of the work focusing on demographic characteristics, economic constraints, and climate forecasts. However, few research concern about the psychological determinants that facilitate or constrain the adaptation behaviour. In this paper, a psychological model was tested to examine how households in China would decide their intention that adapts to climate change. This model is an extension of protection motivation theory involving the climate perception and the social discourse as additional variables. Cognition of an individual always depends on his or her social context, and the social discourse is very important. Data in this work was collected through a national wide survey that involved about a total of 1600. Result from our study shows that the risk appraisal of climate change and the coping appraisal to adaptation will positively affect intention to adopt adaptation behaviour. In addition, the gender of informant and the social discourse about climate change information will influence the decision in a positive way. Information generated from this study can provide functional guidance for improving decision-support systems and promoting adaptation policies.

Keywords: Climate change, Adaptation, Protection motivation theory, Adaptive capacity, Behaviour

Developing a hierarchical framework through integrating qualitative and quantitative information for improving corporate sustainability performance

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Abstract:

As result of technology is rapidly development, electronic industry is considered as an important asset in each country. Moreover, industry is striving for developing corporate sustainability to fulfill the expectations of public. However, it lacks a precise hierarchical framework and approach to guide the industry in improving the performance. Thus, this study adopts fuzzy synthetic method with analytical network process through integrating qualitative and quantitative information for developing a specific hierarchical framework. The information is collected by web crawler from three famous Chinese electronic firms, which listed in Fortune 500. The result enables to offer a guideline for leading Chinese electronic industry in improving the performance of corporate sustainability efficiently and effectively.

Keywords: Corporate sustainability, Hierarchical framework, Qualitative and quantitative information

Household waste recycling in Italy: Do environmental concerns matter?

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Abstract:

In the last decade an increasing number of studies have attempted to identify factors influencing different types of environmentally responsible behavior, including waste recycling. Only few studies explore the link between environmental concerns and household recycling behavior. Some scholars conceive environmental concerns as a hierarchical structure of environmental values, beliefs and attitudes and test their contribution to explain waste recycling behavior. In this hierarchical structure, they differentiate between egoistic, altruistic, and biospheric values. These studies point out that global environmental concerns have a positive impact on the individual propensity to recycle.

The present study points out environmental concerns as non-pecuniary incentives in order to examine the association between general environmental concerns and household waste recycling. We perform our analysis in Italy and consider a period at the end of 1990s in which the policy makers undertook information campaigns aimed at making the population aware of the importance of waste reduction and recycling so we have argued that people's attitudes and behaviors related to environmental waste issues were mainly influenced by their own sensibility.

The paper contributes to the literature in several ways. First, it performs an econometric analysis of the correlation between general environmental concerns and household waste recycling, controlling for many demographic and socio-economic features. Secondly, in line with the previous environmental literature, it considers three types of general environmental concerns - egoistic, altruistic and biospheric - and it sets up economic empirical hypotheses linking general environmental concerns with household waste recycling. Finally, it also takes into account pro social behaviors to perform robustness analysis.

The study uses the Multipurpose Household Survey conducted annually by the Italian Central Statistical Office. The final dataset used in the empirical analysis contains 27,111 observations. The unit of analysis is household head. The dependent variable is measured by the number of waste separate collections. To this end, five different materials are considered: paper, glass, plastic, aluminum and food waste.

Five variables that measure general environmental concerns are the following: (EC1) waste production and disposal; (EC2) pollution; (EC3) climate change; (EC4) resource exhaustion; (EC5) alteration of environmental heritage. On the basis of previous studies, we propose to interpret waste production and disposal as egoistic concerns, environmental pollution and climate change as altruistic environmental concerns, resource exhaustion and alteration of environmental heritage as biospheric

concerns.

Using standard univariate probit models, the paper shows that all variables considered are statistically significant at 1 per cent level and positively associated to household waste recycling. A greater concern for the specific environmental issues is related to a higher likelihood of making waste recycling. However, it is relevant to point out that when the number of waste separate collection increases the magnitude of the marginal effect of the egoistic, altruistic and biospheric concern variables decreases highlighting the relevance of marginal costs.

Keywords: Household waste recycling, Environmental concerns, Pro-social behaviours, Italy

Analysis and integration of informal recycling system in Beijing

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Abstract:

The informal recycling system is the spontaneous and profit-driven recycling system that is opposed to the formal recycling system. There are five main types of practitioners involved in informal recycling: scavengers, waste merchants, middlemen, processing centers, and reuse companies. Among them, the scavengers mainly make profits by buying or picking up recyclable waste from residents for sale. Waste merchants take trash from residents or scavengers and resell them to middlemen for profit. The middleman directly communicates with the waste merchants and processing center, reuse company The main task of the processing center is to dispose of the acquired waste, such as packaging, compression, cutting, etc., and then resell to the reuse company. Reuse companies are usually the terminal of the recycling system, through which the recycling of waste will become a new product flowing into the market.

This article takes Beijing's informal recycling system as a case study. Compared with formal recycling system, informal recycling system has a series of problems because of its own characteristics. First of all, practitioners of informal recycling systems, especially scavengers, tend to have lower education levels and lack of appropriate vocational skills training. Therefore, the recycling efficiency is low, which is reflected in the low recycling rate of waste, the lack of optimized recycling routes, Poor quality. Second, because of the lack of appropriate knowledge and recycling equipment, scavengers often result in different degrees of harm to the surrounding environment during recycling. At the same time, their own security also lacks the necessary protection and is exposed to harsh conditions for a long time, greatly endangering the health of the scavengers. Finally, the larger number of floating population poses a severe test for Beijing's urban safety problems.

However, even though there are a series of drawbacks of the informal recycling system, there is still considerable value in existence. Beijing, as a mega-city, has a staggering amount of rubbish every day, and Beijing's rubbish disposal system has long been overwhelmed. Landfills occupy a large area of valuable land resources, waste incineration has also wrecked a lot of resources, increased transportation costs, the release of a large number of greenhouse gases. However, the amount of informal collected rubbish still occupies a considerable proportion. Once informal recycling is lost, the rubbish disposal system in Beijing will face tremendous pressure.

This article hopes to understand and analyze the informal recycling system of Beijing from both qualitative and quantitative aspects by means of interviews and questionnaires. On the one hand, we can understand and analyze the needs of

informal recycling workers and their problems in work and life. On the other hand, the analysis shows some quantitative data of the informal recycling system of Beijing, such as the ratio, recycling, material flow, cash flow and so on. On the basis of the two, this paper proposes the policy integration proposals of Beijing's informal recycling system and provides a scientific basis for the government's reform of the recycling system in the "convergence of the two networks."

Keywords: Informal recycling system, Domestic recyclable resources, Convergence of the two networks

Quantifying multilevel anthropogenic resources using a hybrid material stock analysis: A case study of buildings in Taiwan

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Abstract:

This study presents a hybrid material stock analysis (HMSA) aimed at revealing the individual stock information at micro-level up to the macro level of aggregate inventory. The traditional top-down model requires limited data to perform macro-level simulation, which fails to clarify the quantities and spatial characteristics of the individual stock. The bottom-up model allows greater flexibility in identifying the individual material stock to the aggregate inventory levels. Yet, the level of study relied heavily on the quantity and quality of input data, which may constrain the investigation scope.

HMSA migrates the limitations of these traditional models, and depends on fewer inputs of material intensity measures to provide an assessment at all levels with high spatial resolution. For illustration, HMSA is applied in evaluating the anthropogenic stock of buildings in Taiwan during the period 2001-2010 with following procedures: (1) employ the top-down approach to estimate the total inflows of material based on the annual consumption of construction materials; (2) incorporate monetary input-output tables to clarify material accumulation; and (3) utilize the bottom-up approach to reveal the spatial distribution of building materials based on building occupancy permit statistics.

The results indicate that the approximately 348 million tonnes of building materials were accumulated as anthropogenic stock for the year of 2001, 2004, 2006 and 2011, comprising of concrete (91%), steel (7%), and bricks (3%). Taoyuan City has the largest accumulated stock volume among the 22 political divisions. An indicator of net addition to stock (NAS) reveals that the highest volume of material stocks took place in the year 2004 with 93 million tonnes, mainly from Taoyuan City (14%). For micro-level analysis of Taipei City with a detailed spatial distribution of individual buildings, Neihu district was disclosed with the highest quantity of accumulated stock, comprising of concrete (92%), steel (6%), and bricks (2%).

Utilization of anthropogenic resources provides a viable alternative for virgin materials to conserve natural resources. The application of HMSA is verified to require less data of material intensity for anthropogenic stock estimation in existing buildings, yield truthful estimation with high spatial resolution, and provide more

reliable extrapolation for regions with limited data availability. This study provides an evaluation framework for future implications on other anthropogenic resources, and the delivered results serve as a foundation for circular economy policy.

Keywords: Hybrid material stock analysis, Anthropogenic resources, Construction material stock, Spatial distribution, Circular economy

Public intentions towards ecological compensation for transboundary river basin based on the theory of planned behavior method

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Abstract:

Transboundary river basin management and protection is a complex issue which involves different stakeholders and administrative regions. Taipu River, as a typical transboundary river in Taihu basin, runs through the Wujiang Direct in Jiangsu Province, Jiashan County in Zhejiang Province and Qingpu Direct in Shanghai City. There exist huge differences on water use of Taipu River between upstream and downstream stakeholders. Since the operation of the Jinze Reservoir in the end of 2016, Taipu River has been the significant water source for the downstream residents who live in Shanghai (in Qingpu, Minhang, Fengxian, Jinshan and Songjiang) and Jiashan. However, industry along the Taipu River especially the textile industry has been well-developed, which brings risks to water supply. Therefore, the water resource conflicts of the Taipu river basin is obvious and intractable. Ecological compensation is considered as a sustainable way to protect the transboundary river basin. Residents' intention and behavior towards ecological compensation is crucial to protect the transboundary river. However, there are few previous studies about the influential factors of public participation on ecological compensation for transboundary river basin.

In this study, theory of planned behavior (TPB) and contingent valuation method (CVM) was used to evaluate the downstream residents' willingness to pay (WTP) on ecological compensation for the transboundary river basin (Taipu River) and upstream residents' willingness to accept (WTA). The TPB model was extended by four additional variables such as situation awareness (SA), risk perception (RP), government job satisfaction (GJS), and ecological compensation cognition (ECC). Face-to-face questionnaire survey was done from October 22nd to December 10th in Wujiang, Jiashan, Qingpu, Songjiang, Jinshan, Fengxian and. Minghang. Two different questionnaire versions were designed to investigate WTP and WTA on ecological compensation across Taipu river basin. The water users in Shanghai were investigated in the questionnaire of WTP test; while the residents along the Taipu river (in Wujiang, Jiashan and Qingpu) were investigated in the questionnaire of WTA test. 498 completed questionnaires were received with a valid response rate of 95.77% and determinants of public ecological compensation intention were explored. Based on the study results, policy-making suggestions were given to improve residents' ecological compensation intention; and public internal thinking and behaviors about transboundary river basin protection would be understood better in the future.

Keywords: Transboundary river basin, Ecological compensation intention, Theory of planned behavior, Contingent valuation method, Taipu river

The influence of income and income gap on residents indirect carbon emissions

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Abstract:

With the growth of economy and the promotion of urbanization, the proportion of residents indirect carbon emissions in residents whole carbon emissions increases year by year. It has been considered that the income and income gap are two of the important factors that affect the environment, energy consumption and the indirect carbon emissions of the residents. This paper extends the IO model which was added some new variables like income, income gap between urban and rural residents and average propensity to consume, the influence mechanism of average consumption propensity on the relationship between “income, income gap and residents indirect carbon emissions” is deduced from the theoretical model, then we calculated the residents indirect carbon emissions in 2002, 2007 and 2012 from the national perspective, and tested the theoretical results from the model. This research finds that: (1) The carbon emissions of the eight consumption sectors show an increasing trend and the most increasing sectors are “Health Care”, “Daily Necessities and Services” and “Living”. (2) “Living”, “Traffic and Communication” and “Food” are the three sectors with the largest proportion of carbon emissions. (3) The proportion of clean energy in eight sectors is increasing, but the growth trend is weak. (4) The influence mechanism of income and urban-rural income gap on per capita indirect carbon emissions is regulated by the average consumption propensity of urban and rural residents. In addition, narrowing the income gap urban and rural residents will not necessarily reduce per capita indirect carbon emissions. (5) The influence of income and urban-rural income gap on residents indirect carbon emissions increasing year by year and the relationship between income gap and indirect carbon emissions shows an inverted U type.

Keywords: Income, Urban-rural income gap, Average consumption propensity, Residents indirect carbon emissions

Sustainable inbound logistics supply chain planning and optimizing through BPR and ERM

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Abstract:

With the continuous growth in demand for reducing emissions of conventional pollutants and greenhouse gases and improving the efficiency of enterprise operation, there is a need to study the various parameters and drivers of sustainable development, especially in supply chain management. Sustainable supply chain management has been gaining increasing attention within both academic and industry for making the business competitive. Currently, there are few specific and complete inbound logistics models, which cannot be widely accepted for its poor performance in economic, social and environment. Therefore, the data in several segments of inbound logistics of a few typical companies were collected and analyzed to find the key drivers of sustainability. Meantime, we put forward a framework for evaluating the sustainability of the logistics. And then, we analyzed and evaluated the sustainability of the existing logistics model and determined the optimization directions. Finally, based on business process reengineering (BPR) and enterprise resource management (ERM) and value chain analysis, we put forward a new inbound logistics model for sustainable development. The findings show that vehicle fuel consumption, storage area, storage time, pickup time and information management level are the most important contributors to system sustainability. What's more, we proposed mixed pickup patterns to adapt to different types of goods and different distances of operations, and reduced the storage operation links by combining DC with a distribution center or staging area, which are resulted from pre-packaged sequencing and largely depend on information management level of the company. Besides, we further defined the model so that different companies can apply the most adaptable one. In this study, a new type of inbound logistics operation model is proposed, which is supplemented to the research in this field and has practical guiding significance for the related enterprises.

Keywords: Sustainable supply chain, Inbound logistics, BPR, ERM, Operation model

Utilizing of nano-SiO_2 soaking method to promote the performance of concrete containing recycled aggregates

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Abstract:

The research aims to utilize the nano-SiO_2 sol soaking method to improve the mechanical and microscopic properties of recycled concrete aggregates. Five concentrations (0.5%, 1.0%, 1.5%, 2%, 2.5%) of nano-SiO_2 sol were used to soak the recycled mortar aggregates (RMA). After soaking, the properties (density, water absorption, and crushing index) of nano-SiO_2 improved RMA (SI-RMA) were determined. Then the optimal group was used to prepare the concrete for measuring compressive strength, drying shrinkage, and chloride penetrability. Results indicate that the 2% concentration is the optimal. It reduces the water absorption and crushing index of RMA. Furthermore, it provides an extra compressive strength of 6% for RMA collected from high strength concrete and of 5% for RMA collected from common strength concrete. In addition, the resistance of chloride penetrability was improved, indicating a better durability performance of concrete prepared with SI-RMA. Authors believe the positive results were ascribed to the potential activity of recycled aggregates. In effect, the cement produces a large amount of $Ca(OH)_2$ at the same time when the hydration produces a large number of C-S-H gels that dominate the strength of concrete. The $Ca(OH)_2$ in concrete has certain negative effects on mechanical properties and durability of concrete. For example, the "wall action" caused by the growth of $Ca(OH)_2$ crystal weakens the cementation force between the cement colloid and aggregates. However, when the building was dismantled, $Ca(OH)_2$ becomes the source of potential activity in the waste concrete because $Ca(OH)_2$ can react with active SiO_2 and water to produce a hydrated calcium silicate (C-S-H). That is to say, the waste concrete has potential activity. Nano SiO_2 is not only active, but also easy to enter the C-S-H gel holes in waste concrete. As long as the reaction condition of old concrete is available, nano-SiO_2 can react with $Ca(OH)_2$ in old concrete to form C-S-H and continuously generate the filling effect upon waste concrete. Additionally, the nano-SiO_2 bonded on the surface of RMA not only strengthens the surface but also enter the new concrete during mixing. It thereby enhances the interface between the recycled aggregate and the new cement paste. Overall, the research combines the nanomaterial technology and construction waste recycling. By the nano-SiO_2 soaking method, the mechanical and durability performance of RMA were enhanced due to the potential activity and the filling effect.

Keywords: Construction wastes, Recycled aggregate, Nano-SiO_2

Embodied carbon emission caused by residential consumption in Jing-Jin-Ji region: Based on the perspective of producer and consumer responsibility

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Abstract:

The Jing-Jin-Ji Region is one of the most important economic growth poles in our country at present. Driven by the regional development policies, the inter-city exchanges have become closer. However, with the economic development and the improvement of the residential consumption level, the negative effect of resource and environment was growing and the Jing-Jin-Ji Region is under the pressure to reduce carbon emissions. Consequently, focusing on the residential CO_2 emissions and the "carbon leakage" in Jing-Jin-Ji Region will help reduce and eliminate inequity of carbon emissions and promote coordinated low-carbon development .The MRIO model of Jing-Jin-Ji Region was established in this study which based on the China's extended input-output tables from 2002 to 2007.We calculated the embodied carbon emissions which caused by residential consumption from the perspectives of producer responsibility and consumer responsibility, and also analyzed the "carbon leakage" existing among Jing-Jin-Ji Region. As the results suggest: (1) During the period of 2002-2007, the total CO_2 emissions from residential consumption in the Jing-Jin-Ji Region increased greatly. Beijing and Hebei Province had the same situation as the whole region, while there was almost no change in Tianjin and its CO_2 emissions increased slightly; (2) The proportion of Hebei Province's residential CO_2 emissions in the Jing-Jin-Ji Region was always the largest. Moreover, as time extended, the gap between not only Beijing and Hebei but also Tianjin and Hebei had expanded gradually; (3) From the perspective of producer responsibility, we found that the residential CO_2 emissions in all regions were mainly caused by the consumption of residents in its own region. Furthermore, from the perspective of consumer responsibility, there was "carbon leakage" caused by residential consumption of final demand, transferring from Beijing to other regions, in particular, to Hebei province. As well as Hebei suffered more and more large amount of net CO_2 emissions that transferred from Beijing and Tianjin during this period. Tianjin played the role from "the recipient of carbon leakage" to "the transferor of carbon leakage" in the Jing-Jin-Ji Region, while the carbon leakage of Tianjin was not obvious. On the basis of these conclusions, attention should be paid to residents ' CO_2 emissions in the process of low carbon coordinated development in the Jing-Jin-Ji Region, as well as the inter-provincial carbon transfer. Therefore, we also focus on setting up the reduction mechanism of CO_2 emissions from residential consumption and scientifically defining the responsibilities of each province on carbon mitigation in the Jing-Jin-Ji Region.

Keywords: The Jing-Jin-Ji, Residential CO_2 emission, Responsibility of producer and consumer, Carbon leakage

What factors are related to implement the energy performance contracting for urban residential housings and how do these factors affect? A systematic study based on interpretive structural modeling method

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Abstract:

In order to effectively reduce the energy consumption of urban residential housings, promote the application of energy performance contracting (EPC) on urban residential energy management, and give full play to the cooperative utility of multi-subject, multi-parameter and multi-factor in energy performance contracting for urban residential housings, this study adopted the Interpretive Structural Modeling (ISM) method to present the factors affecting the implementation of EPC in urban residential housings, cleared the interaction relationships between different factors, and illustrated the effects of various factors on implementing EPC in urban residential housings. Firstly, 47 factors affecting the implementation of EPC in urban residential housings were screened out based on literature review. Next, the scattered factor relationship information in the related papers was transformed into the adjacency matrix. Finally, the factor directed hierarchical structure diagram of implementing EPC in urban residential housings was constructed through the computation and combing of reachable matrix, reachable set and antecedent set. With the help of the ISM method, the relationships between these factors in the literature are digitized, aggregated and graphed, and the key information is effectively excavated and displayed. In addition, this paper quantitatively analyzes the relationships between the various factors, scientifically defines the subjects, the media, and the variables of implementing EPC in urban residential housings, vividly reflects the complex system structure of the EPC for urban residential housings, fully shows the driving forces of energy price, policy, financing, project organization and living needs, and realizes the integration of system study method and literature study method. The research results showed that: the factors of implementing EPC in urban residential housings were divided into three levels. The implementation of EPC in urban residential housings was regarded as a target. The 7 factors of project, energy-saving technology, customers, contract, Energy Service Company, external environment, risk were defined as the core theme factors. The 32 factors, including project organization process and other factors, were the central bearing factors. The other 8 factors were the underlying driver factors. The factors of energy-saving investment, economic environment, market competition, project financing, credit would affect multiple factors in the higher level. The factor of risk was most easily affected by other factors affecting the other core themes factors. Personal needs and behavior change, project financing, project organization process, and economic environment were influenced by the underlying driver factors. On this basis, the corresponding policy suggestions

were put forward based on the analysis results of the directed hierarchical structure diagram.

Keywords: Urban residential housing, Energy performance contracting, Factors, Interpretive structural modeling

Horeca food waste and its ecological footprint in Lhasa, Tibet, China

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Abstract:

Consumer food waste in developing countries becomes increasingly important as they continue to urbanize and raise the income of their inhabitants. However, there are few empirical studies on the scales, patterns, and impacts of consumer food waste in emerging economies (compared to industrialized countries). Here we report an exploratory study on the amount of Horeca (hotels, restaurants, and cafés) food waste and its ecological footprint in Lhasa, Tibet, in western China, based on a direct weighing bottom-up approach of 35 representative restaurants in 2011 and 2015. We found that, on a per capita level, Horeca food waste in Lhasa declined from a high-level close to western countries (129 g/cap/meal) in 2011 by 23.4% to 98 g/cap/meal in 2015, due mainly to the reduction among local residents as a result of recently issued strict regulations (especially those targeting official extravagance and governmental reception meals at public expenses). On the contrary, as a main tourism destination, tourists showed an increasing trend of food waste on a per capita level and contributed over half to the total Horeca food waste in both 2011 and 2015. This also leads to, together with other factors such as growing dining-out frequency of local residents, a sharp increase (39.7%) of total Horeca food waste in Lhasa from 2011 (15 kt) to 2015 (21 kt). The total ecological footprint of wasted food in the Horeca sector of Lhasa in 2015 is equivalent to 81,000 hectares, almost two times the arable land area of Lhasa.

Keywords: Consumer food waste, Ecological footprint, Horeca sector, Lhasa

Is China possible to complete the RPS target in 2020?

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Abstract:

After the essential switch from quota for renewable energy power generation to proportion of renewable energy accommodation in electricity consumption, renewable portfolio standard (RPS) has now become one of the most powerful policy tool towards China's renewable energy curtailments. This paper analyzes the feasibility and rationality of the provincial RPS target in 2020. After comparing the annual RPS data in 2015 and 2016 from National Energy Administration, this paper finds out typical provinces based on the progress of executing, introduces several beneficial measures taken in those provinces which improve RPS indicator, and discusses main factors that influence the completion of RPS target from source-grid-load physical framework to coordinate policy mechanism. We conduct scenario analysis on the implementation of RPS from 2016 to 2020 based on data collected from provincial energy or electricity development schedule in the period of the Thirteenth Five-Year Plan, especially focusing on thermal unit transformation, self-provided power plant management and power system interconnection. Provinces were finally divided into three types according to their status and potential to complete RPS target. The empirical results demonstrate that 15 provinces' target level is too strict for them to achieve while other six provinces such as Qinghai and Ningxia have already completed it. Meanwhile, the rest ones can approach goal as long as executing rigid policy portfolio together with a coordinated development plan of the renewable energy power station and grid construction.

Keywords: Renewable portfolio standard, Renewable energy policy, Scenario analysis

Environmental impacts due to informal gold extraction in the Peruvian Amazon

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Abstract:

The Peruvian Amazon is threatened by mining activities resulting in significant and irreversible environmental impacts. These include a vast deforestation of Amazon rainforest, water, soil and air pollution due to the emissions generated from activities and materials depletion in the rudimentary processes used to extract ores (e.g. mercury), impacts to biodiversity (e.g. bioaccumulation), and others. The complexity of this sociotechnical system (i.e. the mining system), grasping miners, social disparity in the region, and inefficiency of the central and regional governments allows these activities to expand their boundaries, progressively.

To understand the environmental impacts and hotspots of informal gold mining in the Peruvian Amazon this study uses the Life Cycle Assessment methodology. The USEtox and IPCC models were selected to assess the following environmental impacts: human toxicity, freshwater ecotoxicity and climate change. Moreover, to better assess the different scenarios, a specific calculation tool was developed whereby five predominant extraction systems were selected and modelled. These gold extraction processes are technologically precarious and in general terms similar, and include: terrain preparation, extraction of soil/mud, gravitational processes, gold recovery using amalgamation techniques to separate gold from alluvial formations, and, in some cases, mercury recapture. Despite the similarities, important differences persist, such as different yields, resources and machinery use (e.g. dredges, excavators) and operation sites (i.e. river based versus piedmont). Therefore, is relevant to assess them individually.

Preliminary results show that for all systems, human toxicity and freshwater ecotoxicity values are governed by the mercury emissions in the gold recovery activities, as well as mercury ore extraction and freighting activities. However, the total displacement of mercury within the system suggests that altered natural stocks of mercury due to soil removal could be, under certain conditions, more relevant than mercury use in the system. In fact, deforestation is a major consequence of these activities and is generated due to direct (i.e. mining activities) or indirect (e.g. access to the mining area) impacts, depending on the type of mining system. Moreover, deforestation has a major contribution on the environmental impacts related to climate change. Finally, is important to note that although human toxicity, freshwater ecotoxicity and climate change are frequently studied separately, in this system a direct relationship between them was observed.

Keywords: Life cycle assessment, Informal mining, Mercury, Human toxicity, Deforestation

How much does circular economy contribute? Cost composition of a towel in China

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Abstract:

Circular economy is recognized as the panacea for environmentally friendly development and sustainability, as it changes the traditional 'take, make, dispose' model of production and can help decrease the material and energy consumption. Confronted with large amount of discharges, textile industry is one of the pollution-intensive industries in China, which calls for a win-win strategy. This research made a case study of towel industry in Gaoyang County, Hebei province, where over 60% companies produce towels. They have already established circular economy based on circular water consumption and conduct different kinds of innovation as well. While corporate innovation mainly contributes to economic output, circular economy intends to eliminate material and energy consumption. To evaluate the effect, resource productivity (RP), considering both material input and economic output, seemed suitable. Current research related to RP mainly focuses on countries or industrial parks, in which case RP can be decomposed into various kinds of raw material consumption to analyze contribution. However, when it comes to a specific industry, it is hard to use RP as the only measurement. On one hand, the categories of raw materials are too simple to further analyze. On the other hand, raw materials may occupy a limited amount of input. Therefore, we presented a new perspective of evaluation. Based on field research and interviews in Gaoyang, we disaggregated the cost of towel into several parts, including raw materials cost, energy and water consumption cost, labor cost, operating expense, and tax. As circular economy makes effect on raw material cost, energy and water cost, it is easy to know how much it contributes with the cost composition. In addition, the decomposition can serve as a benchmark of this product. The cost composition also indicated the influence of market on corporate behavior, which is often ignored in research concerning circular economy.

Keywords: Circular economy, Towel industry, Cost decomposition, Resource productivity, Corporate innovation

The input-output analysis for food waste anaerobic treatment: A Beijing case study

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Abstract:

In recent years, the collection and disposal of food waste and its related environmental impacts have attracted worldwide attentions. It is estimated that each year the amount of wasted food accounts for about one third of the annual food production in the world. Due to the dietary habits and cultural customs, the output of food waste in China has always been at the forefront of the world. Owing to lack of reasonable treatment, large amount food waste not only caused serious land, water and air pollution, but also caused serious food safety problems. Anaerobic treatment method for food waste, not only solves the food waste pollution problems, but also make full use of the retained energy in food waste. Therefore, from the perspective of supply chain, this paper takes the process of food waste anaerobic treatment in Beijing as the research object. Comprehensively used the life cycle method and input-output method, detailed analysis the process of food waste collection, transportation and processing consumed resources, the costs and the economic and environmental value of the final productions. Implement the food waste anaerobic treatment detailed accounting of the economic effects and environmental effects. Finally, we analyzed the current input-output efficiency of the anaerobic treatment system for food wastes in Beijing, discussed the problems existing in the supply chain and put forward some reasonable suggestions for the improvement.

Keywords: Anaerobic treatment, Life cycle method, Input-output method, Economic and environmental impacts

Material-energy-financial analysis of biomass to power system: Case study from Japan

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Abstract:

Biomass wastes take up large proportion of waste generation, especially in local areas. Thus, utilizing biomass waste as recyclable resource is of great importance in promoting local cycle-oriented society. In this research, we review the development of biomass utilization policies, biomass town projects, and the implementation in Japan. Several patterns of utilizing biomass wastes have been established such as composting, biogas production, and electricity generation. However, many biomass projects lack comprehensive planning and are facing an embarrassing situation because of the imbalance of demand-supply and cost-benefit. To explore whether sustainable biomass to power system could sustain by itself or not, this research introduces a systematic method by integrating three critical factors, which are material, energy and finance, to analyze the operation of biomass project.

Hita is a local city of Oita Prefecture, which has the highest renewable energy supply proportion in Japan. Hita has established its local circular system including biomass waste and wood biomass utilization since later 1990s. Hita biomass project is one of the first biomass power generation projects in Japan. The biomass utilization center turns kitchen garbage and industrial wastes to biogas, which is used for electricity generation. In the last decades, the energy policy such as Renewables Portfolio Standard and Feed-in Tariff brought chances to the electricity market, which helped to improve the financial situation of the project. Based on the operation data from field survey, we build up the material-energy-finance simulation to see the evolving trajectory of the biomass to power case in four phases, which are test, adjusting, FIT, and aging. Later, utilizing the simulation model, we conduct scenario analysis of 13 patterns combining variables of initial construction setting, feedstock choice, and fertilizer consumption on the biomass project operation. Changing the feedstock of biomass wastes, promoting the consumption of fertilizer byproducts and integrated waste management could be effective from technical perspective; however, flexible institutional and management adjustment is needed. Based on the findings, some policy and management implications are concluded to improve the operability of biomass to power utilization projects in the context of Japan. Also the case could be used for comparison of biomass to power in other countries and regions.

Keywords: Biomass, Local circular system, Material flow analysis, Energy flow analysis, Financial flow analysis

Plastic recuperation and valorisation fit for use: Use of selective flotation in the separation of plastics from complex waste streams

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Abstract:

Complex waste streams, like municipal solid waste still contain, besides the digestible organic fraction, valuable and recyclable plastic materials. An extensive amount of these collected plastic waste streams are nowadays incinerated with or without energy recovery or landfilled. Recycling of complex plastic waste is a requisite in the path towards a circular economy. These heterogeneous plastics (often from post-consumer origin) are usually highly contaminated and therefore need pretreatment, like washing, deodorizing and deinking. In order to obtain a qualitative end product the complex mixture of polymers should also be sorted as much as possible in mono polymeric materials. However, the separation is not straightforward as the different polymers often have overlapping density ranges and sensory techniques fail because of contaminations, or the 'foily' materials. The solution might be found in selective flotation, in which the polymers are separated in aqueous medium with the aid of air bubbles. Hereby, the hydrophobic properties of the polymer surfaces are altered through adsorption of surface active components and/or oxidative pretreatment.

This presentation gives understanding in the fundamental insight into the separation of the valuable plastic fraction through selective flotation by linking the surface energy with the different separation parameters. The surface energy components (Lifshitz-Van der Waals, acid and base) of the polymer surfaces are determined by contact angle measurements. The selective flotation experiments are conducted in a self-designed flotation column. Finally, the plastic particle – air bubble interaction is investigated. A range of different polymer materials (PET, PVC, PE, PP, PS) is investigated based upon their presence in two real plastic waste streams. The used surfactants vary in ionic character (anionic, cationic and non-ionic) and hydrophilic-lipophilic balance. First results are promising as the contact angles of treated material indeed decline up to levels that allow separation.

Keywords: Plastic separation, Selective flotation, Surface energy, Contact angle, Surfactants, Recycling, Circular economy

Sustainability in supply chain through 3D printing opportunity

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Abstract:

1.Introduction

3D Printing (3DP) is officially known as additive manufacturing, is a disruptive technology at current age. It is a revolutionary technological where an abstract digital design file can be transformed to a physical object as long as there is a 3DP. Whilst this technology has been established around 1980, with the most of key patents protection period is expiring, 3D printable contents are relatively easily accessible to the public (MMLC Group, 2014). It has then fostered the availability of open source, which allows printable content owners to upload their creative work to Internet sharing platform. The open sources in 3DP community have posed a dilemma between innovation technology like 3DP and to what level of its openness to the different stakeholders in the value chain. It is impacting every stage of the product development lifecycle of supply chain, from the product upstream manufacturing to packaging, presentation, and delivery.

2. Impact of 3DP on product utilization rate with cloud manufacturing

The high flexibility that 3DP allows manufacturers or organizations to complete the manufacturing activities at any location, where manufacturers do not need to seek for low wage labor countries to complete the manufacturing processes. It then allows manufacturing centers locate as close as the inventory and distribution centers (Geraedts et al, 2012). This technology will help organization to achieve global-localization strategy under digital supply chain, for example, cloud manufacturing (Sebastian and Omera, 2015). The continuous development of the open innovation business model under 3DP technology, cloud manufacturing, etc., will make supply chain rather straightforward. In printable industry, a combination of 3DP providers, printing materials providers, service providers, software providers and printable content provider are sufficient to revolve an industry. Under this business model, the tracking of resources used in the product production will automatically set in. The user of 3DP will access to clear guidance of the usage level of products they intended to print, and will receive alerts when over-under consumption of printing materials during production phase.

3. Academic and practical implication

China is experiencing industrialization growth. As a consequence, there is a large number of raw materials or pollutant emissions. Researchers are more inclined on discussing upstream issues, such as improving resource utilization rate and control manufacturing factory pollutant emission level to the environment. But what the gap is that current research does not discuss on the managerial issues of adoption of

innovative technology in addressing the issues. From the point of view of stakeholders in the value chain, what matter most is to what level of openness is appropriate to the value chain when it is considering contribute to the open community and benefit from it, while at the same time, the own intellectual properties are being taken care of.

The question of whether 3DP has the potential to disrupt supply chain and address the sustainability issues from the point of view of increasing utilization rate, or it will be just another incremental step in the supply chain evolution is still remain untapped in academic research.

Keywords: 3D printing, Cloud manufacturing, Open innovation, Resource utilisation rate

Examination of deposit-refund systems in Baltic countries

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Abstract:

In deposit-refund systems (DRSs), deposits are paid during the purchase phase, and they are refunded if the used products are brought back to collection points. Originally, DRSs were introduced voluntarily by manufacturers and retailers, to decrease manufacturing costs. However, decreasing virgin material costs meant suppliers were no longer incentivized to collect used products, which carries a cost burden, and littering and throwaway society became common. Nonetheless, DRSs can give consumers sufficient incentive to take clean used products to collection points, which can attain high collection rates. Therefore, governments often try to introduce mandatory DRSs to prevent littering and achieve cyclical societies. Suppliers, however, usually do not accept mandatory DRSs, because they are required to establish depositing systems and manage used product transactions.

In Baltic countries, Estonia introduced mandatory DRSs for beverage containers in 2005. From around 2010, Lithuania and Latvia began discussing the introduction of mandatory DRSs. Lithuania started mandatory DRSs in 2016, and one of the topics in the 2018 election campaign in Latvia is the introduction of mandatory DRSs. This raises interesting questions on the DRS issues in Baltic countries: (1) how were mandatory DRSs introduced in Estonia and Lithuania; (2) how were the suppliers' cost-burdens under the mandatory DRSs and (3) what are the differences between Latvia and Lithuania in introducing the mandatory DRSs. The answers to these questions may have policy implications for other countries attempting to solve littering and achieve cyclical societies with mandatory DRSs.

To answer the information to the questions above, the author visited the three countries in 2014 and 2017 and conducted extensive interviews with various stakeholders related to the mandatory DRSs. The author also observed a variety of situations involving mandatory DRSs in the countries during these visits. Based on the acquired information, this study summarizes the following perspectives on Estonia and Lithuania's mandatory DRSs: (a) how the mandatory DRSs work; (b) how the waste collection schemes affect the mandatory DRSs; (c) how the mandatory DRSs have been discussed and established; (d) how the mandatory DRSs affect littering and collection of the used products; (e) how social background affects the introduction of mandatory DRSs; (f) how other countries have influenced the mandatory DRSs; and (g) stakeholder opinions about the mandatory DRSs. Predictions about all the above points are provided for Latvia.

Keywords: Mandatory deposit-refund systems, Baltic countries, Suppliers' cost-burdens

Tracing the flows of construction and demolition waste in the Netherlands

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Abstract:

Of all the waste produced in the European Union (EU), 27 members, in 2010, 34% has its origin in the construction and demolition (C&D) sector. For the Netherlands, this rate is even higher, i.e. 40%. In the Netherlands, the recycling rate of C&D waste was already 94% and 3.5% had a useful purpose by retrieving energy. Even though the recycling rate of C&D wastes is very high, it is not clear in which way the waste is recycled, and challenges exist to come to truly circular construction and urban planning. Next to that, the definition of a “useful application” is wide. The national policy for waste treatment in the Netherlands, gives minimal requirements for waste treatment. For several materials this is, unfortunately, incineration with energy recovery and landfilling even though better options might be available. In December 2016 the fastest growing city in the Netherlands, Utrecht, passed a motion stating that circular building should be the norm. Considering the large amount of building material needed in Utrecht for the growth of the city in the coming decade, there is a large potential for circular building.

The goal of this research was to understand the possibilities to decrease the use of primary materials in the building sector, by promoting high quality recycling of construction and demolition (C&D) waste. High quality recycling of waste is defined as waste recycling within the same product line. In this study, the state of C&D waste recycling in 2012 was assessed. With this information, more insight was gained in how high quality recycling can be increased. The state of the C&D waste streams in the Netherlands was studied by means of a material flow analysis. The analysis shows that 90% of the C&D waste in 2012 was recycled or incinerated with energy recovery. Merely 11% of the total weight of the waste appears to be recycled within the building sector. The literature study towards re-use and high quality recycling technologies of the three largest C&D waste streams, stony materials, metals and wood, shows that there are several technologies available for this purpose. Therefore, the barriers seem to be in other parts of the system. By means of a qualitative research, stakeholders in the C&D waste recycling system were asked for their view towards future recycling of building materials. In general, the stakeholders agreed that sorting of the materials, the economic climate and the type of building materials are the main bottlenecks that withhold high quality recycling. When talking about buildings planned to be demolished, waste materials should be re-used and recycled within one sector, to reduce environmental impacts, making this a key topic for local governments. This will lead to efficient use of materials, and reduce the environmental impact of products, by reducing energy use and CO2 emissions. In addition, it will bring economic advantages, as the supply chain is working together in

order to re-use and recycle the materials. However, surprisingly collaboration is still a pending matter within the Dutch building sector.

Keywords: Construction and demolition waste, Circular economy, High quality recycling, Systemic analysis

Economic rationalism or administrative rationalism? Curbside collection system building and management in Sweden and Japan

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Abstract:

Both Sweden and Japan are leading countries in environmental policies in Europe and Asia respectively. However, the household waste recycling rate is more than twice as high in Sweden as in Japan, at 47% in Sweden and 20% in Japan. This difference cannot be fully explained by population size or environmental consciousness, as is commonly asserted. The author believes that differences in curbside collection systems could be a contributing factor. Assuming that's the case, how and why did these differences arise?

This presentation suggests that Sweden and Japan have taken different paths on a paradigm shift toward a circular economy/sound material-cycle society. That is, Japan's policy has been strongly based on administrative rationalism, while Sweden has favored economic rationalism.

This hypothesis is based on the following observations. Japan has established a series of policies toward building a sound material-cycle society. However, it has not sufficiently deployed measures extending to the production and distribution stages in order to reduce municipal household waste. For example, the city of Nagoya decided not to begin charging for waste and didn't adopt a deposit system or similar program. Nagoya's advancement of 3R was weighted heavily toward cooperation among citizens, administrators, and citizens' groups to ensure thorough separation and disposal of waste, in response to an emergency declaration from the mayor on the shortage of landfill capacity.

On the other hand, Sweden has adopted policies intended to promote waste reduction at the production and distribution stages, such as charges, deposit systems, and policies reflecting the extended producer responsibility (EPR) principle. The circular economy policy in Sweden, and sound material-cycle society policy in Japan are established in line with their original paradigms. The term "circular economy" also shows strong evidence that Sweden has favored economic rationalism; whereas the term "sound material-cycle society" indicates that Japan is based on administrative rationalism.

In order to test the hypothesis, this presentation comparatively analyzes the discourses of major stakeholders with particular focus on curbside collection system building and management.

In Sweden, the producers are responsible for collecting, processing and recycling, while the administration is responsible for planning and providing information. The norm that it must be easy to sort the waste at home is shared at all decision levels.

Accordingly, systematic improvement of curbside collection systems has been implemented, which has drastically increased the recycling rate.

In Japan, responsibilities are shared among the national government, municipalities, producers, and consumers. The “emission” responsibilities of consumers, as well as the necessity of promoting consumer awareness, are broadly shared. However, systematic thinking has not been introduced. As a result, simple, primitive stations are mainstream in Japan, in which it is not easy to sort the waste at home.

In conclusion, the differences between the two countries are explained without contradiction by the suggested hypothesis.

Keywords: Curbside collection system, Economic rationalism, Administrative rationalism, Sweden, Japan

A framework for circular economy implementation in the tourism sector

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Abstract:

Tourism greatly contributes to and, at the same time, is one the most vulnerable industry of environmental degradation. Many of the tourist activities are based on the availability of natural ecosystems in good condition and accessible to tourists.

Circular Economy (CE) is considered as an efficient way to overcome critical environmental impacts and natural resources scarcity in different sectors. CE aims to overcome the take-make-dispose linear pattern of production and consumption, proposing a circular system in which the value of products, materials and resources is maintained in the economy as long as possible. However, the application of the concept in the tourism sector is still unexplored and more efforts should be done to understand the potentialities of Circular Tourism. The final goal is to define a framework to support tourism destinations in implementing CE practices. First, to evaluate the relevant literature on the topic (CE & Tourism), the academic search engines Scopus and Web of Science were employed. As the research did not return significant contributions to the topic, the frameworks for CE practices proposed by scholars were reviewed. In this step, the R-list approach was identified as the most suitable for our analysis. These approaches were critically analyzed and the 10-R framework was selected and re-arranged to evaluate the potential implementation of CE practices in the tourism industry. In the second step for each of the 10-R we identified CE practices that may be transferred and applied to a touristic destination. Once the practices had been established, they were framed to evaluate at which level it is possible to apply it, according to their potential implementation at destination level (decision-makers, local authorities, NGOs, industry associations), firms level (hospitality, bar & restaurant, tourism facilities, tour operators, travel agencies), and consumers level (travelers). Next, the CE practices were organized in relation to the visitor experience (before, inside and after the vacation). Finally, the potential contribution of the 10-R practices on the social, economic and environmental sustainability was evaluated.

Results show that, even if CE has not been explored in the field of tourism, its principles and related practices have a great potential to ensure a balanced development of the industry, actively contributing in the achievement of long-term sustainability goals. Findings will also provide a solid baseline to further investigate the impact of CE practices on touristic destinations' stakeholders.

Keywords: Circular economy, Tourism, R-list approach, Best practices

End-of-vehicle recycling practice: Challenges and opportunities in Chinese market

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Abstract:

With booming development of auto industry, China has become the country with the most car ownership all over the world. To improve resource utilization efficiency and embrace sustainability, auto industry and Chinese government pay increasing attention on end-of-life vehicle (ELV) recycling business and renewable regulations. There exist segmental studies about ELV, such as material recycling, disassemblability analysis, dismantling technique and strategic policy, while little systematic review on the recent development of Chinese ELV recycling industry. This paper is motivated by the urgent requirement of ELV recycling business and environmental sustainability claim. The ELV recycling practices including disassembly, part reusing, material recycling, resource recovery and geographical discrepancy of Chinese market are summarized and highlighted, as well as the strategic policy lunched by Chinese government. The review concludes on the need for cost-effective procedures and researches in order to promote ELV recycling industry development.

Keywords: ELV recycling practice, Disassembly technologies, Renewable resources, Strategic policy, Barriers and challenges

Dynamics of urban food demands and related water-carbon footprints: A case study of Beijing

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Abstract:

Food is one of the basic resources supporting the urban society. Driven by the continuous growth of urbanization, demands for food resource have been and will continue to be rising in the foreseeable future in urban areas of China. Since most of the food was produced in hinterland areas, the environmental footprint pressure has been posed to source places through trans-regional or global trade. Presented in this paper is a dynamic analysis of urban food demands and related water and carbon footprints from 1978-2015 of Beijing city. An eco-efficiency index was constructed to reveal the efficiency change of food consumption. The results shown that: (1) The total food consumed in 2015 was 8.8 million tons, increased by 3.3 times compared to 1978. Correspondingly, the water and carbon footprints have increased by 6.1 times and 4.4 times, respectively; (2) With regard to the structure, there was an evident transition, from staple food based to non-stable based, and from vegetarian diet based to a plant-derived and animal-derived food equally based diet; (3) Beijing city has also faced challenge of over-consumption with high proportion of meat, resulting in high per capita environmental footprint and health risk. (4) Several measures were proposed to alleviate environmental footprint pressure associated with urban food consumption, i.e., improving production efficiency, promoting localized production and supply, advocating green and healthy consumption.

Keywords: Food demands, Environmental footprint, Life cycle assessment, Beijing

Anthropogenic modifications of the nitrogen metabolism in the Beijing megacity, China

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Abstract:

Rapid growth of urbanization process is associated with high nitrogen flows and subsequent environmental consequences in the urban ecosystems. Cities consume resources and produce wastes in amounts that are incommensurate with the populations they contain. Nitrogen is indispensable for sustaining human activities through its role in the production of food, materials and energy. This has encouraged significant anthropogenic modifications for a large quantity of nitrogen flow in, through and out of the urban areas. To address the critical issues, the megacity Beijing was chosen as a case study to identify the main metabolic components to the flows and transforms that comprise a city's nitrogen metabolism processes employing models and methods from ecological science. In this study a substance flow analysis was performed by dividing the urban system into a number of subsystems: industry, agriculture, household consumption and waste management. The metabolism as nitrogen manifests itself in flows throughout the socioeconomic and environmental compartments is quantified based on various data sources. The results showed that the total nitrogen inflow increased from 293.6 Gg (1 Gg=109 g) in 2010 to 349.9 Gg in 2015, human activity resulted in 84% of nitrogen input by means of imported animal feed, human food, fossil fuel combustion, synthetic fertilizers and nitrogen containing chemicals; meanwhile, more than 69.3% of them was released into the atmosphere. Flows to the livestock, atmosphere, and household were clearly largest, with total integrated inflows plus outflows from these compartments accounting for 21, 34, and 16%, respectively. The flows through the agriculture to the household components decreased most obviously, considering the food consumption patterns in Beijing have shown an increase in the percentage of animal products (by nitrogen mass) from 39% of the total in 2010 to 46% in 2015, shifting a growing demand for the imported food outside the city's administrative boundaries. Moreover, the flows from combustion of fossil fuels showed marked growth, and managers must find ways to reduce this trend, options for a more sustainable use of nitrogen in the city are also discussed.

Keywords: Urbanization, Nitrogen metabolism, Substance flow analysis, Household consumption, Beijing

The transition towards low-carbon cities: The input-output based scenario analysis in Sydney

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Abstract:

Cities play a critical role in assisting countries in transforming towards a low-carbon society. City planners are urging to push the low-carbon transition with a high degree of enthusiasm around the world. Many pieces of literature suggest that the low-carbon development policy should consider systematic and comprehensive transformation and linkages throughout the whole economy. However, there is a lack of a method that can model the spatial and sectoral changes for cities under the low-carbon transition policy. In this study, we use a multiregional input-output table (MRIO) for the year 2013 as the base table which includes 3 regions for Greater Sydney, one for the Greater Sydney, one for the rest of Australia and finally one region representing the rest of the world (RoW). We translate Sydney's planning into four scenarios covering 1284 economic sectors. The corresponding time series input-output tables are developed for the four scenarios from 2013 to 2041 using modified RAS method. The result will inform and assist city planners in building a low-carbon city.

Keywords: Low-carbon transition, Cities, Input-output analysis, Scenario analysis

The total material requirement of cities

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Abstract:

Assessing the total (direct plus indirect) raw material requirements (TMR) of urban areas, customized to demographic, economic and infrastructure features of individual cities, is essential to advance urban sustainability. This has been poorly understood in the past due to limitations of data and methodology. This paper applies a new and rapid approach to assess the patterns and magnitudes of annual TMR for six cities in USA and China from three perspectives: production-, consumption- and community-wide (metabolic) inflows. TMR community-wide of Chinese cities is dominated (62~86%) by industrial production requirements, compared to U.S. cities (21~44%), with Chinese cities re-exporting significant proportions (39~58%) of total inflows. Direct raw material inflows are a small percentage (18~53%) of TMR community-wide. By sector, infrastructure and food supply sectors dominate (81~84%) the TMR community-wide of U.S. cities, while this proportion is still significant but varies (26~65%) in Chinese cities, indicating the importance of these sectors worldwide. Interestingly, from the consumption perspective, all six cities have similar ranges of per capita TMR consumption (22~30 t/capita/year U.S. cities; 29~57 t/capita/year Chinese cities, with Tianjin the outlier); in all cases dominated by infrastructure and food supply sectors (73~85%), and by business capital activities (62~88%). The portion of TMR consumption attributed to household activities is relatively lower. Household TMR consumption is higher for Chinese (5.5~9.5 t/capita/year) compare to U.S. households (3.8~5.8 t/capita/year), reflecting the rapid growth of buildings in Chinese cities. The analysis promotes deeper understanding of material requirements customized to each city by sector and activity, informing key future sustainable material management strategies.

Keywords: Raw material, Material requirement, Urban, Direct and indirect

Water-energy nexus of biomass power generation in China: Tradeoff between CO_2 emissions and water consumption

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Abstract:

Water and energy are two elements of interdependence, in particular for electricity generation systems. As biomass wastes has been considered a promising alternative to coal for power generation in China, it is necessary to comprehensively understand the water-energy nexus of biomass power generation for its future development. This study adopted the tiered hybrid life cycle analysis to estimate the CO_2 emissions and water consumption of biomass power generation from crop residues (corn-straw), forestry residues (Larch-residues) and energy plant (Salix). Results show that the life-cycle CO_2 emissions of China's biomass power generation are 69.9 g on average to generate 1 kWh electricity. Water requirement for Salix- and Larch-residues-based power generation are about 2.45 L/kWh, of which 87% are direct water use for power plant. While water footprints of corn-straw-based power are as high as 38.25 L/kWh, dominated by indirect water use in agricultural activities. Given that the Chinese government aims to increase the biomass power generation capacity to 30 GW by 2020, biomass power could contribute a 2% reduction in carbon intensity and could save 154 and 158 million m^3 of water if Salix or Larch residues were respectively adopted as fuel. To achieve the same emission reduction target, however, extra 6288 million m^3 of water is needed when using corn-straw as feedstock. Therefore, biomass power generation technology should be cautiously developed by considering local water resource constraints, biomass residues availability and the tradeoff between emission reduction and water consumption.

Keywords: Biomass power generation, CO_2 emissions, Water consumption, Hybrid life cycle analysis, China

The study of water management during shale gas exploration

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Abstract:

The exploration of shale gas depends heavily on large amount of water input, while generates lots of wastewater output. Whether from the prospect of environment or the prospect of economic, the water management has become the key problem in the exploration progress of shale gas. The article focus on the key water consuming parts of the shale gas exploration – hydraulic fracturing progress, and build a double objective inexact programming model considering the uncertainties of the water volume needed for each well hydraulic fracturing progress and the uncertainties of the flowback water volume as well as produced water volume. The aim of the proposed model is to try to find the trade-off between economic objective (economic cost) and the environment objective (the total volume of fresh water needed during the hydraulic fracturing progress) under uncertain environment. An application to water management of china shale gas exploration is presented to demonstrate effectiveness of the model. The article finds that (a) the high cost of onsite treatment is the main obstacle of the effective recycle of produced water. (b) economic cost and environment cost of the shale gas water management is sensitive to the uncertainties of the water volume needed for each well hydraulic fracturing progress and the uncertainties of the wastewater volume. (c) decision makers may get different system cost with different risk preference.

Keywords: Shale gas, Hydraulic fracturing, Water management, Uncertainty, Multi-objective programming

Evaluation of the collaborative performance of green supply chain management in battery manufacturing enterprises: A case of China's electric bicycle battery enterprise

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Abstract:

Applying green supply chain coordination management is an important strategy for battery manufacturing enterprises, which can effectively develop the campaign of "green industrialization" and promote to recycling of resources. Aiming to improve the green supply chain performance well, firstly this paper constructs a collaborative management model to evaluate the performance of battery manufacturing enterprise from the internal and external supply chain, based on the theory of supply chain. After that, this paper makes an empirical analysis on the system efficient and green performance of the enterprises' green supply chain. As TIAN NENG is the largest electric bicycle enterprise in China, here we take it as an example. The results show that the overall green performance of China's electric bicycle battery manufacturing enterprises is well, but with obvious fluctuation. The internal green performance is relatively stable, and there needs new power to get improvement; The external green performance fluctuates fiercely. The results also show the battery manufacturing enterprises should improve the level of waste collection and recovery, increase the efficiency of residual heat recovery and utilization, and improve the organization of green supply chain.

Keywords: Green supply chain, Cooperative management, Performance evaluation, Battery manufacturing

Water-energy nexus in shale gas wastewater management: An optimization-based approach

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Abstract:

One of the critical challenges facing shale gas industry is the potential negative impacts it poses on the surrounding environment and ecosystems. In particular, proper management of high salinity wastewater generated in hydraulic fracturing has been one of the pivotal questions within the shale gas sustainability discourse. In Marcellus shale play, the majority of shale gas wastewater is currently recycled for future fracking jobs. While recycling shale gas wastewater could help minimize the overall water use in the fracturing process in the short-term, developing a viable long-term management strategy is crucial particularly when a well-pad becomes a net water producer. Direct disposal of the high salinity wastewaters into Salt Water Disposal (SWD) wells is the most common strategy in the U.S. However, increased seismic activity in the proximity of these wells in addition to high associated transportation costs has limited the application of this strategy.

We employ a holistic optimization-based decision-making approach to help guide economically conscious management of shale gas wastewater in Marcellus shale play in Pennsylvania (PA). This approach takes into account the feasible treatment technology for handling the salinity of shale gas wastewater which could be as high as 350,000 mg/Liter, thus limiting the applicability of most conventional desalination technologies. As such, we investigate membrane distillation (MD) technology which holds great promise for desalination of high salinity wastewaters. While MD has relatively high energy requirements, its low operating temperatures makes it suitable to be integrated with waste heat sources. We propose to utilize available waste heat sources at natural gas compressor stations (NG CS) in the United States where over 60% of the energy input is currently released as waste heat. A range of wastewater management alternatives from direct disposal in SWD wells, to advanced centralized MD plants, decentralized MD plants at NG CS, and onsite treatment units using MD are investigated. A linear programming (LP) model is presented that takes into account the associated cost of treatment, transportation, and injection of wastewater. The optimization model investigates optimal wastewater management strategies by incorporating detailed treatment cost data obtained from techno-economic assessment (TEA) of MD for treatment of shale gas wastewater. The optimization model is applied to four real-world case studies in Greene and Washington counties in southwest and Susquehanna and Bradford counties in Northeast Pennsylvania where major shale gas development activities take place. The results of this analysis reveal that onsite treatment of wastewater at shale gas extraction sites in addition to

treating shale gas wastewater at NG CS where available waste heat could be utilized to offset the energy requirements of treatment process are the most economically promising management options. Further, using a combination of onsite treatment and treatment at NG CS using MD could result in over 60% benefit over direct disposal into SWD which translates to over $16 million/year benefit in certain locations. The implications of these findings for sustainable management of high salinity wastewater from other shale gas formations will be described.

Keywords: Shale gas wastewater management, Membrane distillation, Waste heat at natural gas compressor stations, Techno-economic assessment, Optimization

The consequential benefits of algal biofuels

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Abstract:

Human population growth and changing diets across the world have led to increasing demand for food, and particularly for nutrient and protein rich animal products, including fish and shell fish. As a result, aquaculture has become the fastest expanding food production sector, and ocean resources have been exploited at unprecedented rates, leading to marine biodiversity loss, food web changes, and other alterations of ocean ecosystem functions and structures. Fishery and aquaculture activities are primary drivers of ocean resource depletion, because wild fish are captured for both direct human consumption and as feed for cultured fish.

Microalgae oil has long been investigated as a potential source of biofuel. Microalgae avert some of the most challenging problems of terrestrial bioenergy crops, such as direct and indirect land use change, and in some cases can be grown on low-quality water sources that are unfit for terrestrial crops. While the indirect effects of terrestrial biofuels have typically been negative, there is a potential that microalgal biofuels could provide some positive indirect impacts on ocean resources. De-fatted microalgae meal is produced as a co-product of microalgal biofuel. It is rich in nutrients and has great potential to effectively provide protein, lipids, vitamins and energy to cultured fish. Using defatted microalgae meal from various strains as a replacement for fishmeal for farmed fish species has been studied with various fish species. In general, partial replacement of fishmeal with de-fatted microalgae meal improves cultured fish growth performance and health. Therefore, the production of microalgal biofuel can potentially reduce the demand of fishmeal from wild catch, and indirectly effect the ocean resource depletion.

This study develops a new indicator for use in the life cycle assessment (LCA) of microalgal biofuels (and bioproducts) that is relevant for assessing consequential impacts on ocean resources. The indicator is based on primary production required (PPR), a concept that has been used previously in ecological assessments and LCAs to evaluate the ecological impacts of fisheries and aquaculture. Results show that the PPR reduction resulting from algal biofuel co-products varies with the cultured fish species (e.g. Nile tilapia can tolerate 75% displacement of fishmeal with defatted microalgae, while the Atlantic salmon can only tolerate 10%) thus leading to highly variable but potentially significant reductions in PPR demand from ocean resources as a consequence of microalgal bioduels.

Keywords: Ocean resources, Life cycle assessment, Algal biofuel, Co-product, Primary production required

Revealing the trade effects on the life cycle greenhouse gases of materials: The Japanese case

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Abstract:

Decoupling environmental impacts from economic growth has been a global objective in the past twenty years leading to the creation and implementation of decoupling indicators such as resource efficiency and eco-efficiency. Still, as underlined in Van der Voet et al. (2003) and Van der Voet et al. (2004), these two indicators remain difficult to apply at the material level due to the difficulty to define and calculate the specific environmental impacts and economic value of materials, i.e. the impacts and value generated materials considering their life cycle (production, use, disposal).

In previous works Dente et al. (2018), we developed a methodology to address the above shortcomings and reveal the life cycle greenhouse gas of materials produced in Japan. The novelty of the research consisted mainly in the solving of the double counting issue due to the inextricable intertwinements of material supply chains and the clear distinction between upstream and downstream phases of materials. Main impacting products were found to be crude steel, petroleum refinery products, cement, paper, marine fishery, dairy cattle farming, aliphatic intermediates, vegetables and rice. Those impacts were nonetheless calculated considering only Japanese geographical boundaries. Therefore, the validity of these results should be also studied in the context of international trade. Multi-regional input-output analysis (MRIO) is the recognized methodology to study environmental impacts embodied in trade. However, in spite of recent improvements, available MRIO databases still miss the required high level of details necessary to study materials. Therefore, in this research, the GLIO model (Nansai et al., 2012) is used as it offers a high level of details (393 sectors) combined with a good description of the Japanese trade.

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Keywords: Life cycle of materials, Greenhouse gases, Multi-regional input-output analysis

Life cycle inventories of the cradle-to-gate stage of the materials for lithium batteries in China

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Abstract:

In order to improve accuracy and reliability of life cycle assessment studies concerning the electric vehicles and lithium ion batteries in China, the localized life cycle inventories of those commonly used materials for lithium batteries are greatly required. Based on the methodology of life cycle assessment, firstly the general unit-process model of elementary flows of resources, energies and emissions were established. Then the life cycle inventories of the related materials, energies and transport services were collected and processed from databases domestic and abroad, as well as the data of producing processes from Chinese enterprises. As a result, the targeted life cycle inventories of the materials for Li-ion batteries in China were obtained, along with the corresponding 95% confidential intervals through Monte-Carlo simulations. According to the inventories analysis, it was found that among the materials studied, the polyethylene separator made by wet drawing process, lithium hexafluorophosphate, carbon nanotubes, lithium nickel manganese cobalt oxide and nickel cobalt aluminum are with relatively higher primary energy demands and greenhouse gas emissions in their cradle-to-gate stage. Besides, among the cathode materials studied, lithium iron phosphate consumes the lowest nonrenewable mineral resources. In addition, through a comparison with GREET, we found that the energy consumptions and greenhouse gas emissions of the commonly-used lithium battery materials in this study are significantly higher than that drawn from the latest version of GREET, which was found to be stemmed from many difference in the processes of modeling and data acquisition between this study and related studies in GREET.

Keywords: Life cycle assessment, Li-ion batteries, Energy demand, Greenhouse gas emissions, Mineral resources

Integrated hybrid input-output modeling for the interaction between the food-energy-water system and the economy

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Abstract:

Energy production requires water, and in the case of biofuel, land that may otherwise be used for food production. Water supply and treatment require energy. Food production requires both energy and water. It has been recognized that to achieve efficient use of natural resources and to decrease the vulnerability of built systems to global environmental change requires understanding of this 'food-energy-water (FEW) nexus'. Among the various approaches to studying the FEW nexus, input-output methods been applied to calculate the life cycle carbon emissions and footprints of technology options, embodied energy and virtual water, and network characteristics. Compared to other input-output methods, the integrated hybrid input-output (IHIO) method is advantageous in its integration of top-down sectoral economic data and bottom-up unit-process life cycle inventory data to achieve greater clarity and accuracy in accounting the environmental impacts of the product.

The total output of the FEW system accounts for 4.8% of the gross domestic production (GDP) in the U.S. in 2016 (calculated from U.S. national input-output accounts). The FEW system also has upstream connections to manufacturing, construction, and chemical industries, and downstream connection to consumers of food, energy, and water. As such, large-scale changes in the FEW system have the potential to cause non-negligible change in other parts of the economy and the national GDP. Past studies on FEW have not investigated this interaction between the environmental and economic aspects of sustainability, to our knowledge. In this study, we developed a multi-regional IHIO model that disaggregates all the FEW sectors in the U.S. national input-output accounts into commodities in physical units at the level of Petroleum Administration for Defense Districts. The model integrates data from numerous sources on the production, prices, inter-state transfers, and life-cycle inputs and outputs of agricultural products, energy products, water supply, and water treatment. As a case study, we analyzed a scenario of renewables penetration in the U.S., where all current coal-fired electricity generation are replaced by wind and solar electricity generation. We calculated the resulting change in the energy and water footprints, the economic output of various sectors, and the GDP of the U.S. Our model is expected to have versatile applications in life cycle analysis, designing FEW systems, and policy analysis, and the data collection effort will benefit future studies on FEW nexus in the U.S.

Keywords: Food-energy-water nexus, Input-output model, Renewable energy, United States

Economic vulnerability of the united states agricultural sector facing pollinator decline

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Abstract:

Of the many goods and services provided by ecosystems that are crucial to humans and their industries, one critical service with high economic value is pollination by insects. A lack of this service would be a significant detriment to ecosystem biodiversity and function, but also to human nutrition and the United States national economy. Agricultural sectors and related sectors (fiber, drugs, and fuel) are directly and indirectly dependent on animal-mediated pollination, the majority of which is provided by insects including both commercially-managed species and wild species of bees and other insects. Production of pollination-dependent crops has increased at a faster rate (50-62%) than the global population of managed bees (45%) as many factors including loss in habitat, monotonous diet, climate change, pests, parasites, management practices, the emergence of colony collapse disorder (CCD) in 2006, and other stress factors influence the fitness of pollinators around the world. In addition, wild insects in all regions including natural protection areas suffer, declining up to and exceeding 75 percent over the last 27 years in biomass and with decreasing biodiversity. This disparity between production demand and pollinator supply can be a concern nutritionally as well as economically, especially in Europe and North America which are particularly vulnerable as pollinator stocks in these regions decline. Previous work on the economic value of insect pollination has spanned many cultivars of crops across diverse landscapes around the globe, and previous estimates differ among sources without reconciliation and lacking bounds of uncertainty.

The present work aims to address the shortcomings of previous estimates by developing an understanding of the dependence and associated uncertainty of the U.S. economy on pollination services by insects, focusing on crops grown in the United States. Using publically available data from the USDA (United States Department of Agriculture) and NASS (National Agricultural Statistics Service) as well as field study data on pollination of specific crops available in the literature, we quantify economic dependence of crops in the United States on pollination services by insects, updating existing coefficients of dependence of sample crops when possible, bounding uncertainty of estimates, and limiting the scope to U.S. landscapes. We compile data at a national, state, and county level, considering the

spatial relationship between the economic value of pollination, region-specific pollinator forage suitability, and crop-specific agricultural areas. Price and production data integration reveal areas of the U.S. which are highly dependent on pollination service by insects as well as those areas most vulnerable to decline. The implications of these findings include directing conservation and suitable forage revitalization efforts, advising future policy development, and supporting the incorporation of valuable ecosystem goods and services as a component of life cycle assessment.

Keywords: Pollination, Pollination service, Ecosystem service, Biological resources, Insect pollination, Resource consumption, Resource scarcity

Critical supply chains and key nodes for urban food-energy-water nexus: A structural path analysis of multi-regional input-output model

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Abstract:

With the increasing urbanization but growing resource scarcities, the securing provision of fundamental resources as food, energy and water (FEW) has become a unique challenge for urban sustainability. This is not only because of continuous demand of resource imports from different regions for urban area, but also due to the complex interrelationships among FEW systems. In such context, exploring the interrelationship between FEW nexus along supply chains cross multi-regions is very essential to find effective policy intervention points and priority areas for actions. This paper investigated the interactions between FEW flows driven by final demands of Beijing city at different nodes along their supply chains, using structural path analysis and multi-regional input-output model of China 2010. The results shows that, (1) The source regions of FEW provision, presented overall neighborhood pattern, for instance, Hebei, Jiangsu, and Shandong near Beijing are three largest contributors of tran-regional FEW provisions; (2) Among the twenty most important regional nexus paths which accounting for 82.0%, 61.9% and 92.5% of FEW demand for Beijing, such as other services in Beijing, agriculture in Inner Mongolia, Hebei and Shandong provinces; (3) Regarding the largest contributor of other services in Beijing, transport, storage and post (Beijing) and hotels and catering service (Beijing), agriculture (Anhui and Hebei), chemical products (Xinjiang) are the key notes to affect the FEW nexus.

Keywords: Urban FEW nexus, Multi-regional input-output analysis, Structural path analysis, Supply chain

Measuring ecological capital: State-of-the-art, challenges, and future trends

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Abstract:

Natural capital is consisted of nonrenewable resources, renewable resources and ecosystem services. It plays a vital role in furnishing goods and services to human beings. Since Gretchen Daily's book and Costanza et al. article in Nature published in 1997, a large number of researches have been kicked off to assess natural capital. This paper first defines renewable resources and ecosystem services as ecological capital on the basis of its active and self-maintaining attributes. Then it reviews major developments on ecological capital assessment methods in the period of 1997-2017, and summarises each approach's strengths, weaknesses and applicability, including economic valuation approaches, and biophysical assessment approaches: material flow analysis (MFA), emergy analysis, exergy analysis, ecological footprint (EF) and life cycle assessment (MFA). It points out the main challenges in measuring ecological capital: (1) In-comparability and inconsistency in assessing approaches, and (2) neglecting virtual ecological capital – transferred (imported and exported) ecological capital in assessment. Finally, it proposes suggestions for future research: (1) synergies of various methods in measuring different types of ecological capital, and (2) incorporation of methods like input-output tables (IO) and ecological network analysis (ENA) to assist the assessment of virtual ecological capital.

Keywords: Natural capital, Ecological capital, Ecosystem services, Virtual ecological capital

Blockchain applications as circular economy enablers

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Abstract:

Until now the implementation of the circular economy concepts has often been significantly hindered by a lack of information about availability, quality, quantities, price, location and other relevant information about secondary raw materials. The resulting gap between technological recovery potentials and actual uptake of recycled material can be shown by the example of the German recycling system: Although the waste infrastructure in Germany is one of the most advanced with overall recycling rates of over 80%, currently only about 14 per cent of the material used in the industry are recyclates.

Against this background this paper will systematically analyse the potentials of the blockchain technology as cornerstone of the Industrial Revolution 4.0. This digital technology enables a broad, safe online database with a transparent, real-time information network visible among all actors. Information is shared in an anonymous and encrypted form. As a possible result the establishment of wider markets will push exchange and communication between businesses forward leading amongst others to more efficient supply chains, B2B markets and industrial symbioses. Thus by making use of those blockchain technologies and smart contracts the coordination of recycled raw materials can be improved significantly. Furthermore, the share of secondary raw materials in production can be increased while the need of primary resources and waste is reduced.

The paper investigates and evaluates the potentials of using blockchain mechanisms in a circular economy and examines to which extend the circular economy could benefit from such a digital transformation. Based on specific best practice examples the paper outlines how digital technologies can be implemented in the circular economy and analyses the resulting barriers and challenges. Taking the example of a regional network of cable companies generating a relevant amount of homogenous plastic waste, concrete cost saving potentials as well as investment requirements have been estimated if blockchain applications would be used to pool these waste streams in an optimal way that would enable a direct feeding back into the production process. At the same time issues of data security and cooperation between otherwise competing companies have been discussed. A key challenge has been the specific accountability of partners in this network if inadequate waste sorting leads to a stop of the production process.

Based on the concrete blockchain application, further digitalization technologies are assessed:

- Cyber Physical Systems that could carry information about quality, quantity, location and price of contained raw materials through the entire life cycle of products.

- Sensoring that provides real-time collection of data about the precise location and amount of waste enabling more easy, efficient and predictable logistics in the waste management sector.

- Digital market and logistics platform: smart contracts, which are based on the principle of blockchains, can automate transactions and mechanisms in order to reduce search, administrative and transaction costs for businesses.

The paper aims to make a contribution to a realistic assessment of the digitalization in the waste management sector and draws conclusions on prioritized investment opportunities as well as specific need for further research.

Keywords: Circular economy, Digitalisation, Block chain, Plastic waste recycling

Impact of sandstone quarrying in Keru and Badli, Jodhpur on the health of quarry workers and local residents

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Abstract:

Jodhpur, Rajasthan is one of India's main quarrying and processing centres for sandstone. However, sandstone quarrying is also a major polluting industrial sector. The pollution starts with mining of sandstone from the quarries and its transportation to stone cutting units/plants distributed in and around Jodhpur city. The main objective of this study was to evaluate the impacts of sandstone quarrying on the health and living/working environment of the quarrying workers and nearby residents. The study area was near Keru and Badli situated North-West of Jodhpur city. Survey of the site was done and showed that quarrying and transportation processes are directly associated with different types of pollution such as air, noise, and water and soil contamination. During cutting, 30-50% of extracted stone is wasted in the form of the slurry (stone dust mixed with water) and small stone pieces (including stone dust, small stone flakes, chips, etc.). Slurry becomes a major air pollutant after drying, worsening the impact of sandstorms that are usual during summer and rainy seasons. Particle size analysis was done to evaluate the size distribution of particulate matter (PM 2.5 and 10) in the slurry. Significant amounts of PM10 and some amount of PM 2.5 in slurry samples were found. In order to assess health problems in quarry workers and residents, health survey of 68 workers and 12 residents was conducted. Results of the survey show that 65.52 % of the workers were affected by breathing problems (like asthma, tuberculosis and silicosis), 18.97 % were affected by eye problems (like irritation & swelling in eyes, eye infection and poor vision) and 13.79 % were affected by both. Results of the study were compared with previous studies to compare increment in breathing problems in Jodhpur area. A huge increment of 1.57 times was observed compared to 1990s statistics. In order to evaluate problems due to quarrying activities in nearby by villages, a survey of 27 local residents was conducted. Of the 27 residents, 62.96% reported noise disturbance due to transportation activities, 66.67% said that dust levels were very high during quarry working hours and all said that the worst effect of the dust is felt during the summer season. A number of injuries, bone fractures and toppling of stone-carrying trucks were also reported in the study.

Keywords: Sandstone quarrying, Particle size analysis, Impact on health, Air pollution, Silicosis

Environmental impact of sandstone quarrying at Keru, Jodhpur, Rajasthan

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Abstract:

Jodhpur, Rajasthan is one of India's main quarrying and processing centres for sandstone. However, sandstone quarrying is also a major polluting industrial sector. The pollution starts with mining of sandstone from the quarries and its transportation to stone cutting units distributed in and around Jodhpur city. The main objective of this study was to evaluate the environmental impacts of stone and slurry waste generated during sandstone quarrying. The study area was near Keru and Badli situated North-West of Jodhpur city.

Survey of the site was done and showed that quarrying and transportation processes are directly associated with different types of pollution such as air, noise, water and soil contamination which directly affecting the health of the quarrying workers and residents of nearby villages. Most of the cutting units are near the quarrying zone, where cutting and shaping are done. A tremendous amount of water is required for cutting process and 30-50% of extracted stone is wasted in the form of the slurry (stone dust mixed with water) and small stone pieces (including small stone flakes, chips, etc). Currently, most of the stone and slurry waste resulting from cutting is dumped on nearby empty land resulting in the formation of gigantic artificial mountains of waste (upto 5-10 m high). In most cases, nearby land is low in fertility but these practices further decrease soil fertility and also contaminate ground and surface water sources reducing groundwater recharge and drainage. Slurry also becomes a major air pollutant after drying, worsening the impact of sandstorms that are usual during summer and rainy seasons.

To evaluate the increase in quarrying area and changes in local land-use due to quarrying, a time-based study was done using remote sensing (RS) and Geographical information systems (GIS) tools. To assess contamination in the quarry area, 16 soil samples (10 from the site and 6 background soil samples), 4 quarry pit water samples, 3 stone samples, 9 slurry samples, 2 groundwater samples and 2 surface water samples (2 samples from 2 different seasons) were collected from 10 different locations. Physical properties such as total solids (TS), volatile solids (VS), fixed solids (FS), hydraulic conductivity, specific gravity, bulk gravity and particle size were determined for the soil and slurry samples. To study microscopic level differences, mineralogical composition and morphology of the stone, soil and dry slurry samples were analyzed by Scanning Electron Microscopy and X-ray diffraction. Water quality of the groundwater and surface water samples were also determined to assess the impact of quarrying on water quality. Liquid samples were analyzed using ICP-MS and IC to determine the presence of different elements in the samples. The

analysis shows significant intrusion of stone dust in the soil and water sources in nearby areas and changes in original soil properties. After assessing the results of the study, possible strategies will be suggested to reduce pollution and improve the quality of life in the quarrying area.

Keywords: Environment impact, Sandstone quarrying, Leaching, Stone waste, Soil contamination

The environmental impact evaluation system in pulp and paper industry

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Abstract:

As one of the oldest industries, pulp and paper industry is an inseparable part of the society. Mainly sourced from forest, there exist huge spatial heterogeneity in pulp and paper production since the distribution of forest resources is uneven among different countries. Consequently, the bulk trade of pulp, paper and paper products among different counties are essential to meet the needs of citizens around the world. Pulp and paper industry is an energy and resource inputs and pollution emissions intensive industry, and its environmental burdens have been extensively explored. However, the complexity of the industry caused by the trade was overlooked. At spatial scale, since the production and consumption is distributed in different countries, the embodied environmental impacts transfer is not clearly illustrated. This study aims to evaluate the environmental impacts of pulp and paper industry in China from a long time scale by considering the spatial complexity. By deploying data from comtrade, the import and export data of pulp, paper and paper products are firstly got. Secondly, the environmental impacts of pulp and paper in different countries are summarized by referring to literatures and investigation data in China. Thirdly, the annual environmental impacts of pulp and paper in China deducted. The corresponding major environmental impact contributors and countermeasures to reduce environmental impacts are proposed. This study not only evaluates the environmental impacts of pulp and paper industry in China considering the complexities, but also provides guidelines for other bio-based industries.

Keywords: Pulp and paper, Embodied environmental impacts, Spatial scale, Complexity

An integrated solid waste management plan using remote sensing, GIS and linear optimization for Kharagpur, West Bengal

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Abstract:

Remote Sensing and Geographic Information Systems (GIS) can be used to develop efficient municipal solid waste management (MSWM) plans for towns and cities. The objective of this study was to formulate a comprehensive ISWM strategy for a small city like Kharagpur in West Bengal, India. Available data, Remote Sensing and GIS were used to identify areas used for illegal dumping of waste and their increment in size in recent years. Current MSWM system in the city was assessed and a comprehensive plan was prepared to address current deficiencies. Population, population density data and Google Earth were used to formulate a bin plan for 100% collection of waste with source segregation of waste into mixed (biodegradable and inert) and recyclable fractions. The bin plan has a colour code to describe different types of bins in different areas, i.e., market, residential (single storey, apartments) and public places. First, vehicle routing was done manually using GIS for residential and market areas. A cost-benefit analysis was done to choose between one or two-time collection a day. After selecting one-time collection a day routes were further optimized using linear programming to reduce route length and eventually reduce overall collection costs of the system. A suitable site for a landfill, transfer station and waste treatment facilities (composting + recycling) has been identified using the above tools.

Keywords: Identification of dumps, Vehicle routing, Illegal dumping, Route optimization, Bin plan

Quantifying the food-energy-water nexus using multi-regional input-output models

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Abstract:

Food, energy, and water are essential resources for human beings. Food, energy, and water systems are interconnected with one another, as well as interconnected with the production systems of other products (e.g., construction materials, equipment, machinery, and services). It is still a big challenge to quantify the comprehensive interconnectedness of food, energy, and water resources within the whole economic supply chains. This study attempts to quantify the comprehensive interconnectedness of food, energy, and water resources in China using an environmentally-extended multi-regional input-output model. Taking the water system as the core of food, energy, and water systems, we quantify their interactions from two aspects. First, we investigate how the consumption of foods and energy drives upstream water withdrawals and wastewater discharges. Second, we analyze how the inputs of fresh water and wastewater treatment services enable downstream production of foods and energy. This study is the base of food, energy, and water management in China.

Keywords: Water-food-energy nexus, Multi-regional input-output model, Consumption-based

Life cycle environmental assessment of charging infrastructure for electric vehicles in China

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Abstract:

Electric vehicles (EVs) alleviate dependence on petroleum by using other energy resource, thus considerably decrease the gas emissions and enhance the fuel efficiency during operation. Therefore, EVs have gained more attention as an ideal direction of the future vehicle technologies, and have been widely promoted as the ideal alternate of ICEVs in many countries. Recently, assessments on the cradle-to-grave environmental influence of EVs have been a hot topic. However, most researches only focus on the environmental burdens of the EVs without considering other supporting facilities, such as the charging infrastructure. China has ambitious goals in electric vehicle deployment, and has been one of the biggest markets of charging infrastructure for EVs. In China, three types of charging infrastructure are being widely applied: the charging point, the charging station and the battery swapping station, between which an integrated environmental comparison has not occurred. This study presents a comprehensive environmental analysis of different kinds of charging infrastructure to evaluate the energy consumption and environmental impacts in three phases: construction, operation and End-of-Life. The assessment is based on material and energy data from manufacturer and local databases. The outcome of the analysis is expected to be more comprehensive compared with previous researches and support the future planning of China's charging infrastructure.

Keywords: Electric vehicle, Infrastructure, Life cycle assessment (LCA), Industrial ecology

Modelling of dissolved CO_2 transport and hydrogeochemical interaction during CO_2 storage in deep saline aquifers

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Abstract:

CO_2 geological storage is an effective solution to control greenhouse gas emission. The traditional method of CO_2 geological storage is injecting CO_2 into the reservoirs directly, which exists the risk of supercritical CO_2 leaking from reservoir. In this paper, we proposed to inject the dissolved CO_2 into deep saline aquifer to improve the safety of CO_2 geological storage. Experiments were conducted to study the CO_2 solubility in different temperatures, pressures and saline concentrations. Then, numerical simulation software of TOUGHREACT was applied to modelling the dissolved CO_2 transport in reservoirs with different conditions (e.g. temperature, pressure, porosity, permeability, etc.) and injection schemes (e.g. injection volume, injection rate). Furthermore, the hydrogeochemical interaction among dissolved CO_2, reservoir water and sandrock were studied to analyze the minerals dissolution or precipitation, the reservoir water chemical characteristics, and which cause the changes of reservoir porosity and permeability. Therefore, the suitability of dissolved CO_2 sequestration was further discussed. The results of this study are expected to provide an effective and safe option for reduction of CO_2 emission.

Keywords: Modelling, Dissolved CO_2 storage, Transport, Hydrogeochemical interaction, Saline aquifer

Environmental enforcement and compliance on Pennsylvania's Marcellus shale gas wells

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Abstract:

The rapid development of shale gas in the United States raises potential concerns about environmental impacts. This paper examines how environmental regulations are enforced in shale gas development in Pennsylvania's Marcellus Shale and the resulting compliance behaviors. A three-level hierarchical linear model (HLM) is employed to analyze the enforcement and compliance performance of regulators and shale gas operators, respectively, employing data between 2011 and 2017. Significant variation in the environmental non-compliance exists between both wells and operators. The empirical results suggest progressive directions for adjusting environmental enforcement strategies in Pennsylvania and provide implications and references for other regions with similar shale gas ambitions.

Keywords: Shale gas, Environmental enforcement and compliance, Hierarchical linear modeling

Life cycle greenhouse gas assessment of high-speed rail construction in China

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Abstract:

This study estimates the life cycle greenhouse gas (GHG) emission from the construction of a typical high-speed rail (HSR) in China, New infrastructures, including stations, tracks, tunnels, bridges, overhead line equipment, signaling and telecommunications, electrified third rail, road crossings and culverts, require abundant among of input materials (for example, steel and cement), The results showed that the HSR from Zhengzhou to Fuyang, which has been under construction recently with a total length of 267 kilometers, will generate 6.51 billion metric tons of CO2, of which 82% comes from the construction material production and 18% from fuel used on-site and transportation. As a typical Chinese HSR, large numbers of aerial structures are built instead of railway embankment, considering land saving and control of subgrade. The bridges, which account for 93% of the route's length, are responsible for 66% of the total emissions. Cement and steel are the top two materials contributing to life cycle GHG emissions, with shares of 43% and 31% respectively.

Keywords: High-speed rail, Life cycle assessment, Greenhouse gas emission, Carbon footprint, Construction materials

A study on the demand and sustainable supply of copper resources in China

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Abstract:

After 100 years of construction and development, China has built a complete system for the production and processing of copper resources. In China, more than 90% industries are highly related to the copper industry, and it has become an important basic supporting industry in the national economy. However, due to the severe situation of China's copper industry resources protection, the sustainable development is facing many problems. This paper studies the sustainable supply capacity of copper resources in China. In the view of demand, this study forecasts the total amount of copper demand in China between 2000 to 2050 in the field of electricity, electronics, electronics, transportation, architecture and other typical copper resources consumption fields. At the supply point of view, this study predicts supply capacity of copper in China of domestic mineral resources and regenerated copper resources. From the view of balance between supply and demand. We analyzed the supply gap of China's copper resources. The study found that the supply gap of copper resources in China has been increasing in the past decades. With the full utilization of renewable resources, the supply gap of copper resources is expected to be effectively alleviated.

Keywords: Copper resources, Sustainable supply, Supply and demand balance, Circular economy

Trade and transboundary nitrogen footprint in China

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Abstract:

The anthropogenic reactive nitrogen (Nr) has both significant positive and negative impacts for human being and ecosystems, not only terrestrial but also aquatic ecosystems. The positive significance lies in agricultural production and energy supply. The negative effects mainly arise from the Nr losses to the environment, including gaseous reactive nitrogen to the air and potential nitrogen in the water, during food production and fossil fuel combustion. We define the sum of these anthropogenic losses as virtual Nr footprint (VNF), which is a consumption-based calculation. As anthropogenic perturbation levels of nitrogen cycles exceed the proposed planetary boundary (PB), it is emergency that the human took validated methods to measure virtual Nr footprint of regions, especially those agricultural regions with relatively high nitrogen application rates. As the biggest Nr mobilizer in the world, and has a duty to feed the largest population in the world, China not only mobilizing Nr internationally but also within its country's boundary. To track the mobilization of virtual Nr footprint among Chinese 30 provinces in 2010, we employed newly available Chinese multi-regional input-output (MRIO) table with the unprecedented comprehensive inventory of Nr emission in provincial level. Our results show that only 51% of China's Nr emissions are related to products that are consumed within the province where products are produced originally. Besides, up to 15% of the virtual nitrogen footprint are exported outside China. Not surprisingly, provinces with largest VNF are those populous regions such as Shandong, Henan, Guangdong, and Sichuan, where have great growing demand for food. As for the largest net domestic importers of VNF produced elsewhere in China, including some of the most affluent areas, such as Shanghai, Beijing, Tianjin, and Zhejiang. As for the Nr emission responsibility, although the largest net domestic exporters, such as some intensive agricultural regions like Jiangsu, Hebei, Sichuan, and Henan, of very high production-based nitrogen footprints have produced great amount of emission, the main net domestic importers, such as some affluent regions like Shanghai, Beijing, and Tianjin, are the primary demand drivers of Nr emission. Understanding and tracking transboundary linkages between consumption hotspots and production hotspots is a promising way for China to find out pollution transference route and thus to establish an effective regional collaborative mitigation mechanism while meet the global nitrogen demand in an increasing trend.

Keywords: Reactive Nitrogen, Nitrogen footprint, China, MRIO

Urbanisation processes as key for analysing and forecasting construction materials flows: Paris region case study

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Abstract:

Urbanisation processes received little attention in studies on construction materials flows and stocks. Indeed, analysis of past and present flows is generally based on criteria such as population size or gross domestic product. Forecasting of future outflows, often based on average lifetimes set at a national or regional scale, cannot take into account specific urban dynamics (Augiseau and Barles, 2017).

Research on construction materials flows and stocks in Paris region shows that urbanisation processes have a significant effect on resource consumption and waste generation. Stock contained in buildings and networks (road, rail, electricity, gas, district heating and water) is estimated through a bottom-up assessment. Flows in 2013 are studied through the coupling of top-down and bottom-up approaches and forecasted until 2032. Within the region, three areas are distinguished: Paris city (dense and mature urban area, 21,150 cap/km²), Petite Couronne (more recently developed urban area, 6,843 cap/km²), and Grande Couronne (agricultural and industrial outskirts which experience urban sprawl, 463 cap/km²).

Results show that urban structures strongly impact past and present flows. Indeed, past flows, as observed through today's stocks, differ between the three areas in terms of total mass per capita and job, and in terms of mass distribution between built works. Total stock in Paris amounts for 109 t/cap+job and networks only form 10 % of the stock, while total stock in Grande Couronne reaches 181 t/cap+job with networks that represent 40 %. Moreover, networks form 12 to 17 % of today's inflows and 7 to 17 % of outflows in Paris, while they reach 30 to 35 % of inflows and 30 to 42 % of outflows in Grande Couronne. Road renewal works make most of the flows associated to networks.

Buildings demolition dynamics are also linked to urbanisation processes. Demolition is not only driven by ageing but rather by the opportunity to rebuild after demolition. In Paris region, seven of the top ten cities (EPCI and EPT) in terms of demolished surfaces are in the top ten cities in terms of constructed surfaces. Rebuilt surface is in average six times bigger that the pre-existing one. The age of demolished buildings, as observed through the ratio between demolished surfaces between 2009 and 2014 and existing surfaces in 2009, differs between cities and areas. For apartment buildings constructed between 1948 and 1974, this ratio is only 0.1 % in Paris while it reaches 0.7 % in Grande Couronne.

Forecasting assumes construction as a driver for demolition. Ratio between demolished surfaces and constructed surfaces between 2009 and 2014 for each

building type and city is used as a parameter. Future construction is estimated through observed urban development since 2000 and objectives of a regional development plan (SDRIF). Results show that urban renewal (higher share of construction within the existing city) would limit materials consumption compared to urban sprawl. But it would also generate more demolition waste. This calls for a better integration between urban planning and resource and waste management policies.

Keywords: Materials flows and stocks analysis, Construction materials, Urbanisation processes, Urban structures, Buildings demolition, Dynamic flows analysis, Forecasting

Sustainability indicators for biobased chemicals: A Delphi study

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Abstract:

Sustainability is a topic of current and worldwide interest, yet it remains difficult to quantitatively define and integrate the environmental, economic and social domain. In this study we focus on biobased chemicals and the indicators needed to evaluate their sustainability. Biobased chemistry has gained interest and has the potential to tackle some of the environmental, economic and societal challenges the chemical industry has to endure. Still, sustainability impacts of biobased chemicals need to be evaluated and monitored to highlight the advantages and pitfalls of different biobased routes over the entire life cycle. Indicators are a frequentely used tool to measure sustainability and therefore enable adequate policy and decision-making. However, no generally accepted set of indicators has been developed yet for the assessment of biobased chemicals.

This study aims for expert consensus concerning indicators (1) needed and (2) preferred for sustainability analysis of biobased chemicals. The experts will be consulted by means of a Delphi method, an iterative feedback technique wich enables to reach relevant parties. Stakeholders are selected from three core groups in Europe: industry, public sector and academic sector. In a first round, open questions are used to define what indicators are needed to perform an adequate sustainability analysis. In a second round, the defined indicators are ranked by the experts to prioritise the indicators and the weights for the RACER criteria (Relevance – Acceptability – Clarity – Easiness – Robustness) will be determined. By using nonparametric statistics, a realistic determination of consensus between the stakeholders can be made.

As a final output we obtain a prioritised set consisting of quantitative and qualitative indicators for sustainability analysis of biobased chemicals. These indicators can be used by companies, as well as policy makers and academics to make consistent evaluations and comparisons between biobased chemicals. Further research must apply the indicators on specific case studies to evaluate the practicability of the defined indicator-set. A focus group can narrow down indicators for a specific biobased chemical case study based on the weighted RACER criteria.

Keywords: Delphi study, Biobased chemicals, Sustainability, Indicators

Evaluating the improvement measures for e-waste recycling of informal sectors: Case study of Metro Manila, in the Philippines

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Abstract:

In the Philippines, because of the lack of effective legislation, most electronic waste (e-waste) are collected and dismantled by informal sectors in their back/front yards or on the roads/streets. Due to improper handling of e-waste, open burning cables/wires and crushing CRT glass cause both the local environment and the living conditions of these communities. Informal recyclers, including pregnant women and children, are exposed to heavy metals such as lead. However, improvement measures of the condition of informal e-waste recyclers have not yet well studied. This research focuses on the case study of informal e-waste recyclers in a poor urban area in the north part of Metro Manila, where the International NGO conducted a mitigation program to reduce environmental and health hazards in the community for four years (2012-2016). The purpose of this research is to evaluate the effectiveness of NGO's intervention and behavior change of informal recyclers. We conducted field surveys in September 2016 and October 2017. We used mixed method, combining qualitative and quantitative surveys to understand the social and people's behavior change after the NGO's program. Firstly, semi-structured interviews were conducted for key informants. Then, the questionnaire survey was conducted for informal recyclers and their families who living in that area. We received answers from 55 respondents. About personal protective equipment (PPE), 80% of respondents who wore gloves regularly, but there were 50% for masks and glasses. The main reason for not wearing PPE is "Nuisance / Discomfort". Many respondents also choose "Delay work" especially for globes, and "No money to buy" for all three items. Almost all people are wearing what they distributed free by the NGO, and not intended to purchase PPE by themselves. It can be said that people's consciousness for reducing occupational risk has not perfectly formed. Most respondents answered that they satisfy with NGO's programs and recognized the improvement of the surrounding environment and the decrease of dangerous e-waste recycling behaviors. In order to sustain their actions, economic burden is needed to be lightened, and the persistent support from public agencies is also considered important in the long term.

Keywords: E-waste dismantling, Informal recycling, Occupational health, Awareness raising

Future GHG emissions from meat choices and consumption of developing countries with diet preference and income elasticity

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Abstract:

Developing countries' meat consumption per capita has rapidly increased following their population growth. This trend also increases the amount of greenhouse gas emissions (GHGs) from meat production in fast, so many studies research this topic and the focal points of the studies are to find models for global level total meat consumption, to put a point on estimating GHGs with a rough model and to focus on specific local country's estimation. Hence, the purpose of this study is to analyze major developing countries potential changes in GHGs by national diet preference for meat category and idiosyncratic income elasticity. We follow up three steps: (i) Finding a proper model by sifting previous studies' models and predictors, (ii) Predicting major developing countries' meat consumption based on income-increasing scenario using the fitted model in this study, (iii) Drawing the trajectory of GHGs by multiplying UN population trends through predicted meat consumption of developing countries. In a conclusion, we expect to sort out the countries which are more vulnerable and exposed to likely rapid increase of GHGs arising from its diet preference and income elasticity, and to get insights for apt policy proposals from this result.

Keywords: Meat consumption, GHGs, Greenhouse gas emission, Diet preference, Developing countries

Analysis of emergy-based environmental carrying capacity for sustainable development strategies of islands

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Abstract:

The increase of external outputs with the internal resource consumption is essential for the economic growth of islands due to geographical characteristics. Especially, tourism-oriented islands such as Jeju, Hainan, and Hawaii need to estimate the total resource consumption considering not only residents but also tourists. The emergy analysis is a method of comparing the relative abilities of different energies by converting various types of resources such as energy, materials, and information into reference energy. Besides, this is an ecological approach to assess the environmental burden and sustainability inherent in energy. The aim of this study was to estimate the environmental carrying capacity of Jeju, Hainan, and Hawaii and compare the characteristics of resource consumption using emergy analysis. Also, we suggest sustainable ways for development focusing on tourism. The expected results of this study are to be emergy evaluation of the study area, characteristics of islands considering emergy, and sustainable development strategies of tourism.

Keywords: Emergy, Environmental carrying capacity, Sustainable development

Technical efficiencies and marginal abatement costs of industrial sulfur dioxide emissions in urban China

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Abstract:

The sulfur dioxide (SO_2) pollution in China has significant impacts on human health, ecosystems, and cultural resources. Effectively controlling and reducing SO_2 emissions requires accurately evaluating the emissions efficiency, measuring the emissions abatement potential, and estimating the abatement cost. In this paper, we sample the data of 291 cities in China in 2015 and these cities are divided into eight regions according to the economic development and geographical feature. We then estimate the technical efficiencies and marginal abatement costs of industrial SO_2 emissions based on the directional distance function. In addition, we investigate the factors influencing the marginal abatement costs of SO_2 emissions using the regression model.

Keywords: Technical efficiency, Marginal abatement cost, Sulfur dioxide, Emission City

Predicting corporate environmental performance with XGBoost in the energy service company industry

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Abstract:

Drawing on the Natural-resource-based view, businesses are constrained by and dependent upon nature. Accordingly, firms are much more aware of the importance of environmental issues due to the pressure of growing climate crisis. Lack of corporate environmental performance information makes it difficult for determining business strategies, consumers' purchase behaviour, and investors' financial investment decisions. A reliable model for predicting corporate environmental performance is essential to reduce environmental cost and improve firm's reputation. The Extreme Gradient Boosting (XGBoost) algorithm, a statistical nonlinear machine learning approach which can deal with data sparse in some variables, was developed and utilized in this study. 1297 sets of energy service companies (ESCOs) data investigated in mainland China were incorporated in the XGBoost model. The factors considered firm structure, finance performance and social performance and 12 variables of these three domains were selected based on literature review and interpreted into the developed model. The simulation results demonstrate that XGboost model can be effective for ESCO environmental performance prediction, with a satisfactory prediction accuracy marked by root mean square error (RMSE) and mean relative error (MRE). This study also derives several implications of these findings consisting increasing effort in exploring advanced technology, introducing more technicians, and improving the working environment in the ESCO industry.

Keywords: Corporate environmental performance, Extreme Gradient Boosting (XGBoost), Energy service company (ESCO)

Status of solid waste trade in China

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Abstract:

The rapid development of solid waste trade has caused increasing environmental influence. We used solid waste import data to evaluate economic benefit and environmental impacts in China from 1997 to 2016. Four kinds of solid waste import data were considered in this study, including plastic waste products, paper waste products, waste textile raw materials, and vanadium slag. Our results showed that: (1) the total net import of solid waste by weight and by money generally increased from 1997 to 2016; (2) the total weight of imported plastic waste products surpassed one hundred million tons, which accounted for more than 60% of the world's total export; (3) the solid waste could be recycled and offset parts of resource shortage in China, and then generated economic benefits; and (4) the import of solid waste could cause environmental pollution issues. These results indicated that Chinese solid waste trade is helpful for establishing China's important position in world trade, and is beneficial to understanding the influences of the prohibition on economic benefits.

Keywords: Solid waste trade, Economic benefit, Environmental influence

Global stocks and flows of tungsten: 1995-2015

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Abstract:

Tungsten is an indispensable and strategic metal for national economy and defense. It has been widely used in communications, aerospace, military industry, and other high-tech fields. China is the most tungsten resource-rich country around the world and more than 85 % of tungsten is mined in this country. Many studies concerned the supply security of tungsten due to China's domination in its supply chains, but its trade network is currently muddled among countries. This study established a global material stocks and flows network to analyze both the tungsten flows at national level and its international trade at global level from 1995 to 2015. Results indicate that global tungsten production and consumption rapidly increased during the past decades and the production peaked at 87kt in 2015. China is the largest exporter of tungsten's primary and intermediate productions, and developed countries including the USA, EU countries, Japan, and Korea tend to be the main destinations of these tungsten products. A small group of countries play a key role in the global tungsten trade network, which may weaken the tungsten supply chain. Our results indicate that it could have high risks of tungsten shortage for those countries with highly dependence on import. We believe that our results are helpful for understanding resource criticality and supply chain security for policy makers.

Keywords: Material flow analysis, Tungsten, Trade network, Supply chain

Quantifying urban copper resources in the Yangtze River Delta region, China

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Abstract:

Rapid urbanization in China has led to increasing amounts of mineral resources transferring from lithosphere to cities. Copper, as one of the most important metals, is widely employed in industrial products. In this study, we calculated all kinds of the resources of urban copper in the Yangtze River Delta region from 1990 to 2015, including in-use stocks, quantity of scrap, tailings, and urban landfills. A bottom-up accounting approach was used to calculate the in-use stocks from four main end-use sectors, including infrastructure, transportation, buildings, and equipment. The volume of scrap from discarded copper-containing products was estimated by the life span model. The volume of tailings and urban landfills were analyzed by relevant research results, investigations, and survey. Expected results are as follows: (1) the amount of urban copper in 26 cities of the Yangtze River Delta region increased exponentially from 1990 to 2015 due to rapid urbanization; (2) Shanghai experienced the fastest growth of urban copper resources; (3) per capita urban copper resources in five cities are very high, they were Shanghai, Hangzhou, Suzhou, Nanjing, and Wuxi, and this phenomenon was consistent with their urbanization levels; (4) the majority of the copper stocks resided in infrastructure due to the reserves in the power sector (e.g. electric power generation and electric power transmission). Our results are helpful for understanding the potential capacity of copper urban mining and the development of circular economy in the Yangtze River Delta region, China.

Keywords: Copper, Urban mining, Yangtze River Delta, Material flow analysis, In-use stocks

China's soybean trade and its global embodied environmental impacts

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Abstract:

China is the largest consumer and importer of soybeans in the world. Its import of soybean dramatically increased in the last two decades. This has been posing growing environmental impacts on areas that are exporting soybean. This study first depicts the evolution of soybean trade flows between China and its major trade partners mainly including USA, Brazil, Argentina, Uruguay, and Canada from 2000 to 2013. Environmental impacts in terms of embodied carbon, embodied nitrogen, virtual water, and virtual land use associated with China's import of soybean were then evaluated. Finally, a comprehensive assessment of these environmental impacts was displayed with a high spatial resolution of 5 arc-minutes for the year of 2005.

In recent years, more than 80% of soybean supply in China comes from foreign countries, accounting for up to 60% of global soybean trade. The majority of soybean imports were sourced from North and South America, i.e., United States, Brazil, Argentina, Uruguay, and Canada. In 2013, there were 64 million tons of soybeans imported to China, of which Brazil accounted for 50.2%, USA 35.1%, and Argentina 9.7%. The total import equals to 5.3 times the number of production in China.

Virtual water embodied in soybean trade flows from American countries to China increased sharply, from 19.3 billion m3 in 2000 to 104.4 billion m3 in 2013. If the soybean import was produced domestically in China, water with the volume of 35.1 billion m3 to 200.9 of billion m3 would be used, which were nearly two times compared to soybean import. The similar tendency occurred in other environmental indices. During 2000-2013, the virtual land use flowing into China increased from 4.24 million ha to 22.00 million ha, the embodied nitrogen from 0.79 million kg to 4.44 million kg, and the embodied carbon from 52.09 million tce to 287.91 million tce. Globally, we calculated that soybean trade allows a net reduction of environmental impacts of 80%-300% as compared to a hypothetical condition that all imported soybeans were produced in China.

Keywords: Soybean trade, Virtual water, Virtual land use, Embodied carbon, Embodied nitrogen

Recycling of glass and glass-hydrated lime composite as filler in asphalt mixes

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Abstract:

In order to minimize the negative environmental impacts of pavement construction and maintenance, there is an immediate need to quantify the resources and energy savings. Other than the environmental impacts, high economic pressures due to inflation in virgin material's cost as well as limiting natural resources have obliged the decision makers to adopt recycled materials. Waste glass is a nonmetallic and inorganic waste, which is generated worldwide in large quantities. Since, it can neither be decomposed nor incinerated, it is very difficult to reclaim. Previous studies have utilized glass obtained from crushed bottles and window panes as supplement to fillers in asphalt mix. However, pulverization of glass waste to fine powder needed additional energy which increases cost of mix. This study is first of its kind which utilized glass powder produced during cutting and polishing of glass in glass industry as filler in asphalt mix. Glass is primarily composed of silica which is acidic in nature, which can cause a negative impact over moisture sensitivity of asphalt mix. Hence another composite filler is prepared by mixing glass and hydrated lime and its performance in asphalt mix is compared with glass and conventional stone dust filler.

At first, characterization of various materials was done. Physical characterization of all materials was done using specific gravity, particle size distribution and German filler tests. Quantity and quality of clay were assessed using plasticity index and methylene blue value tests. Morphological and mineralogical analyses were then conducted using Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD) techniques. Also, affinity of materials towards asphalt was assessed using pH value and hydrophilic coefficient tests. Secondly, dense graded asphalt concrete mixes were prepared as per Marshall mix design procedure in order to determine optimum asphalt content of mix. Performance of asphalt mixes against rutting, cracking, raveling and long term aging were determined using Marshall Quotients, indirect tensile strengths, cantabro test and mean Marshall stability ratio test. Finally, performance of mixes against moisture was determined using Tensile strength ratio, active and passive adhesion tests.

All studied materials satisfied the criteria for mineral filler specified in Indian paving specifications. Although glass powder modified mix delivered superior performance in comparison to conventional stone dust mixes in terms of strength, cracking resistance, rutting resistance at lower optimum binder content. However, it didn't give satisfactory moisture resistance and adhesion due to predominance of Silica in its composition. Glass-lime composite is proven to be best filler amongst three, since

not only it delivered best performance in terms of strength, rutting resistance, cracking resistance at lowest optimum binder content, but also it displayed moisture resistance and adhesion almost similar to stone dust. Thus utilization of glass-lime composite filler should be promoted as it not only produces economical mixes but also can deliver superior performance than conventional materials.

Keywords: Glass waste, Composite filler, Asphalt mix, Waste management, Sustainability

Investigation of recycled demolition waste over mechanical properties of cement concrete

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Abstract:

Concrete is second most consumed item in world after water. With the rise in urbanization, industrialization and living standards of people, the demand for concrete is increasing exponentially. Coarse aggregates are primary constituents of cement concrete and are responsible for its strength and durability. There is a continual need for large quantities of good aggregates in order to fulfill the everlasting demand of required concrete. This increased demand for aggregates is majorly fulfilled by natural stone mining which causes the extinction of natural lands and increasing environmental concerns. On the other hand, demolished concrete waste obtained from construction and demolition industries constitute severe environmental problems related to their safe disposal. The recycling of demolished concrete in construction applications, could lead to both economic and environmental benefits. This study investigated the characteristics of fresh and hardened cement concrete (M30 grade) prepared using recycled coarse aggregates (RCA) obtained from demolished concrete. RCA were extracted manually from demolished concrete and then adhered mortar was removed from them by pressure washing and repeated heating. Various characterization properties of natural aggregates and RCA namely; impact value, crushing value, abrasion values and water absorption were determined as per relevant Indian specifications. Thereafter, cement concrete mixes (M30) were designed as per Indian specifications by replacing natural coarse aggregates with RCA at varying percentages. The replacement rates were taken as 0%, 10%, 20%, 30%, 40%, 50%, 75%, and 100%. The workability of all fresh concrete mixes was determined using slump cone test. Compressive strengths of hardened concretes were determined after curing period of 3, 7 and 28 days. Statistical analyses of concrete mixes were done using ANOVA, which confirmed that RCA significantly affects strength and workability of mix. Degradation of strength and workability of concrete was attributed to porous nature of adhered mortar on the aggregate surface. However, targeted compressive strength with adequate workability was successfully achieved up to 30% replacement rate. This will not only reduce overall cost and environmental concerns but also can save precious lands spent for waste concrete disposal.

Keywords: Recycled concrete aggregates, Construction and demolition wastes, Cement concrete, Compressive strength, Workability, Sustainability

A review of solid waste materials as alternative fillers in asphalt mixes

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Abstract:

The expansion and maintenance of ever growing global asphalt pavement network requires colossal amounts of naturally mined aggregates. At the same time, a considerable quantity of non-biodegradable solid wastes generated from industrial, agricultural, constructional, municipal and mining sectors are posing serious problems regarding their safe disposal. The increased transportation cost, shortage of land to contain waste landfills, and other problems regarding air pollution, water pollution and aesthetics have forced industries to search for other viable alternatives. The amendment of asphalt mixes with waste materials serve as an avenue not only to limit the quantity of wastes landfilled, but also to reduce the use of naturally mined materials. This will not only reduce the cost of asphalt mixes but also minimize the footprint and negative impact that asphalt pavement industry has on the environment.

Filler can be termed as finest aggregate in asphalt mix. It is an integral part of various asphalt mixes and influences cost, constructability and performance of pavements against various distresses. Since year 1900, numerous studies have been conducted which demonstrated the superior performance of asphalt mixes incorporating numerous waste materials from various sectors as fillers. However, there is a lack of comprehensive research which covers influence of various wastes over different aspects of asphalt pavements. This limits the proper application of these wastes in field conditions. This study reviews the applicability of majorly occurring solid wastes such as fly ash, copper slag, steel slag, bauxite residue, glass waste, ceramic waste, cement kiln dust, rice husk ash, sugar cane bagasse ash, palm oil fuel ash, wood waste ash, sewage sludge ash, dimension stone slurry waste, brick dust, concrete dust, waste coal powder and marine waste as filler in the asphalt mixes. A thorough review of peer reviewed research articles, conference papers, theses, books, patents, industrial and academic reports published over a span of 118 years (1900-2018) is done, which thoroughly covers effects of filler as well as performance of various wastes utilized as fillers in asphalt mixes. The effect of solid waste substitution on strength, moisture susceptibility, rutting, fatigue, cracking and aging resistance have been reviewed in the paper.

Majority of incorporated wastes displayed similar as well as improved results in comparison to conventional filler materials. This behavior was found to be majorly dependent upon the physical and characterization properties of waste, their physical chemical interaction with bitumen and their relative proportion in asphalt mixes. From the perspective of conventional material utilization, the usages of alternative fillers are majorly advantageous considering limiting consumption of conventional fillers

and pertinent environmental footprints. Finally, current gaps in literature are highlighted for further refinement or research.

Keywords: Asphalt mixes, Filler, Waste materials, Sustainability, Waste management

A remanufacturing process planning system using case based reasoning

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Abstract:

Remanufacturing process planning plays a vital role in the success of remanufacturing. However, the process planning of remanufacturing is more complex compared with traditional mass manufacturing due to its' raw material, returned product, whose quality is unique from each other. What's more, the decision of remanufacturing process planning is influenced by customers' requirements on remanufacturing quality, cost and time in practice. This paper presents a remanufacturing process planning system considering customer's requirements which uses case-based reasoning(CBR). In the proposed system, the database software secondary developed based on Access is applied to collect existing cases in remanufacturing enterprise, and Case Based Reasoning is utilized to retrieve reference remanufacturing process planning by reusing the knowledge in the database. An interactive interface is developed for operators to check and modify the retrieved case and thereby meet specific requirements. A prototype system is presented to obtain a reasonable remanufacturing process planning.

Keywords: Remanufacturing process planning system, Case Based Reasoning(CBR), Customers' requirements

Integrating material efficiency and adaptability to reduce the materials used in building structures

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Abstract:

Construction is one of the largest consumers of energy intensive materials, making it a prime candidate to explore strategies to reduce material demand. Typical design strategies include: material efficient design, design for adaptability – to prolong building life, design for deconstruction – to enable future material reuse, substitution of energy intensive materials for lower carbon materials and reuse of salvaged materials. However, there are potential tensions between reducing initial material demand through efficient design, and designing to enable future adaptability. The latter strategy is often perceived to use more materials initially, for example increased floor to ceiling heights will increase materials. However, there has been little work conducted to date that quantifies increases in initial material use resulting from adaptable designs. This paper explores the potential to integrate two approaches – designing structures for adaptability and material efficiency, investigating the impact this has on material use.

One challenge is that adaptability in construction has various meanings, including: capacity for change, versatility of space, potential for change of use, potential to reconfigure internal spaces, potential to extend, and retrofit potential – to improve performance. These different interpretations would likely result in different design changes. A brief review of literatures' interpretation of adaptability is first presented. Then the results of an industry survey are presented, outlining what adaptability means to practitioners. The literature and the survey results are compared, exploring differing views between academia and practice.

A steel framed case study is assessed, investigating design alternatives for the steel frame, comparing these to the baseline, as-built structure. In each structural alternative, material mass, and embodied carbon are estimated. Three different design approaches are explored, the first, an optimised design, to minimise material mass. The second variation explores different adaptable solutions: increasing the floor live load from 3.5KN/m^2 to 5KN/m^2, allowing for change in use from an office to a public building, hotel, gym or retail space; enabling the entire roof to be used as a plant room; and converting the roof for future use as an office space (allowing for future expansion). The third design approach combines the two: an adaptable design that also minimises material mass. The results show that for this case study the final hybrid approach is effective in providing an adaptable solution that also reduces material mass and embodied carbon compared to the base case design. The potential to use the roof for plant had a very minimal increase in embodied carbon

per m^2 (0.37%) compared to the purely optimised design. The increase of the live load, had an increase in embodied carbon per m^2 (16.6%) compared to the optimised design, but it was still 8.8% lower than the base case study embodied carbon. Future work will replicate this approach for additional case studies to ascertain if this pattern holds true for a wider sample of structural designs. In addition, where additional adaptability approaches are identified in the industry survey, the impacts and benefits of these to case study re-designs will be explored and combined with efficient design.

Keywords: Material efficiency, Adaptable buildings, Circular economy, Built environment, Structures

The environmental impact of China's domestic extraction

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Abstract:

Economy-wide material flow accounting (EW-MFA) is a young discipline, which generates indicators of a similar generality as does economic accounting. These material flow indicators (e.g., Domestic Extraction, DE), which have the strength of generating highly aggregate information, have been increasingly applied in many countries to describe the physical dimensions of the economy. However, this same strength may also be considered a weakness, because indicators that are too aggregated hide the different environmental impacts of various material flows.

To overcome this weakness, we combine the EW-MFA method and Life Cycle Analysis (LCA) method to estimate three typical environmental impacts associated with China's domestic extraction (DE): Global Warming Potential (GWP), Abiotic Depletion Potential (ADP), and Respiratory Inorganics (RI). Furthermore, we focus on specific material to find the main material which contributes the increment of them most.

The main results are as follows:

(1) Chinese DE was increased by 390% from 6.3 billion ton to 31 billion ton during 1992-2014. At the same time, GWP of Chinese DE was increased by 206% from 3.5×10^{11} kg CO_2 eq to 1.1×10^{12} kg CO_2 eq, ADP of Chinese DE was increased by 65% from 7.2×10^{7} kg Sb eq to 1.2×10^{8} kg Sb eq, RI of Chinese DE was increased by 439% from 2.1×10^{8} kg PM2.5 eq to 1.1×10^{9} kg PM2.5 eq during 1992-2014.

(2) From a viewpoint of material categories, non-metallic minerals was the biggest contributor (81%) to the increment of DE, fossil fuels contributed the most (73%) to the increment of GWP, metallic minerals contributed the most (84%) to the increment of ADP, and non-metallic minerals was the biggest contributor (63%) to the increment of RI.

(3) In the extraction of metallic minerals, iron ores were the biggest contributor to the increment of DE (77%) and its two related environmental impacts (67% of GWP and

84% of RI), while gold ores were the biggest contributor (33%) to the increment of ADP.

(4) In the extraction of non-metallic minerals, gravel and sand were the biggest contributor to the increment of DE (72%) and its two related environmental impacts (72% of GWP and 74% of RI), while fluorite was the biggest contributor (81%) to the increment of ADP.

(5) In the extraction of fossil fuels, coal was the biggest contributor to the increment of DE (95) and its associated environmental impacts (83% of GWP, 71% of ADP and 51% of RI).

Keywords: Economy-wide material flow accounting, Life cycle assessment, Environmental impact, Material flow analysis, Domestic extraction

Emergy accounting and forecast for assessing sustainable development of Nepal

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Abstract:

Emergy is defined as the total direct and indirect energy of one source type (solar energy) required producing product or providing a service. In emergy method, the sustainability of a system is evaluated through a common unit of solar emjoule (sej). This common unit approach provides fair sustainability assessment in the evaluation of environmental resources, human services and economic resources to human well-being. Emergy indices calculated in the emergy assessment of a system such as emergy money ratio (EMR), environmental loading ratio (ELR), emergy yield ratio (EYR), emergy investment ratio (EIR) and environmental sustainability ratio (ESI) help to understand the overall sustainability of a system and provide clear 'action-guiding power' to decision makers. In this study, sustainability of Nepal's development was investigated using emergy accounting method. Firstly, the emergy of Nepal from 1998 until 2015 was calculated. Secondly, simulation of emergy parameters was then done for the next twenty-five years (until 2040) using Systems Thinking Experimental Learning Laboratory with Animation (STELLA) modeling program. Finally, based on the emergy accounting and simulation results, the sustainable development policies for Nepal was recommended in terms of non-renewable resource extraction, trade, soil erosion control and renewable resources use.

Keywords: Emergy, Sustainability, Emergy indices, STELLA, Nepal

Forecasting electricity demand for residential sector using recurrent neural networks

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Abstract:

Forecasting electricity demand is one of the key process for power system planning, including generation capacity planning, fuel purchase scheduling, and power system management. Common practice in electricity demand forecasting involves analysing the effect of certain variables, such as weather and social factors, on intu a one-to-one relationship with electricity demands or human intuition and expertise. However, these variable selection process can deteriorate the forecasting performance by including the variables that can lead to forecasting errors. Therefore, this study proposes a method that can automatically select only the necessary variables for accurate forecasting based on support vector regression (SVR) and fuzzy-rough feature selection with particle swarm optimization algorithms and can establish precise model based on recurrent neural networks. The model was validated with historical data from South Korea during the period, January 1991 to December 2012. The obtained forecasting performance was evaluated with MAPE, MAE, RMSE, MBE, and UPA values. Furthermore, the performance was compared with the artificial neural networks, auto-regressive integrated moving average, multiple linear regression model, and SVR. The proposed model showed superior performance for all measures employed in this study. By accurately forecasting the electricity demands of the residential sector, this model can improve power system planning decisions while ensuring a reliable electricity supply for the consumer.

Keywords: Electricity demand, Forecasting, Residential sector, Variable selection, Recurrent neural networks

Evaluation of impact of Gorkha-earthquake in Nepal on sustainability by emergy analysis

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Abstract:

The impact of the Gorkha-earthquake on society, economy and environment of Nepal was analyzed by emergy accounting and synthesis. The total emergy use of the country showed a decreased by 10%. This caused the declined of per capita emergy use by 12%, reducing the well-being of people in Nepal. All economic activities of the country were affected, which lowered the national production. The distinct impact was observed in the exports. The export was dropped by 50% after the earthquake. Similarly, the import was also dropped by 2%. Though, economic activities and non-renewable resource use were reduced, the positive impact was observed in the environmental load. The ELR was dropped from 6.79 before the earthquake to 5.98 after the earthquake. This suggests that the economic growth before the earthquake was more sustainable than after the earthquake because the contribution of renewable resources in the economic growth before was higher therefore, the environmental stress was lower.

Keywords: Emergy, Gorkha-earthquake, Emergy indices, Sustainability

Determinants of GHG emissions from electricity system in China

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Abstract:

Existing studies have investigated the factors influencing carbon emissions from electricity generation, but overlooked the impact of direct and indirect interprovincial electricity transmission and final consumers that drive up electricity generation and emissions. This study investigates GHG emissions of electricity system in China from both the perspectives of production and consumption using quasi input-output model(QIO). We also quantify relative contributions of factors to the GHG emission changes during 2008−2015 from both the consumption and supply sides using structural decomposition analysis (SDA). The results show significant difference between emissions embodied in electricity consumption and from production. Moreover, the QIO based SDA reveals factors from both production and consumption side for GHG emission changes: improvement in energy efficiency of electricity production and electricity efficiency of gross domestic product (GDP) contributing to emissions mitigation and economic growth driving up emissions. In addition to production-side GHG emission reduction measures, China should also pay attention to consumption-side measures such as improving the energy efficiency of GDP further.

Keywords: Electricity transmission, Embodied emissions, Electricity system

Closing the loop of materials in the evolving circular economy

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Abstract:

Industrial ecosystem plays a key role in the whole circular economy. However, developing countries like China are experiencing a rapid industrialization process in the past decades, which requires a dynamic and systematic method to promote circular economy. The potential of circulating materials should be reexamined based on the fact that industrial structure is evolving and companies enter or exit a region from time to time. In this study, a complex network named “industry space” was used to reveal the evolution of industries in China, which was constructed by measuring the co-existence probability of different industries based on China Industrial Enterprises Database. It was found that industrial structure became more complex in most regions during 1998-2009 in China, and the evolution was generally path-dependent: a region would probably develop a new industry proximate to its current industries in the network of industry space. We collected cases of eco-industrial parks published in journals and summarized about 120 typical industrial symbiosis pathways to close the loop of materials, which concentrated in several communities (especially the energy-intensive ones) in the network of industry space. Different developing paths lead to great differences in the number, stability and effects of the circular pathways. It was shown that China’s 108 demonstration eco-industrial parks had a significantly higher number of typical IS than other regions, and the number of IS had a significantly higher increasing speed during 1998-2009, owing to the growing scale of industrial ecosystem. However, the regions with a fragmented landscape or in the fringe of industry space could hardly maintain the circular pathways. The results suggest that policy makers should take the evolution of industrial structure into consideration when promoting circular economy, and the industry space method may become a useful decision-support tool for its tracking and predicting potential.

Keywords: Industrial ecosystem, Circular economy, Industry space, Complex network, Industrial symbiosis

Sustainability-oriented water management in dairy industry: A case study in eastern China

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Abstract:

Dairy industry has been variously associated with the problem of water risk. Providing a comprehensive insight, water footprint is widely used to analyze and address water resources issues. Based on water footprint theory and driving forces-pressure-state-impact-response (DPSIR) framework, this paper presents a case of dairy enterprise in Shanghai, China to understand the smart water management of enterprise. Ranch and processing factory, two key components of dairy industry, were chosen to explore water usage in the production chain. We found that there has been a progressive decrease in the water footprint of ranch and processing factory since 2013, which was the result of smart water management. Then, a systematical water risk management system was established for the sustainable development. Therefore, water footprint assessment and water risk management are fundamental strategies to ensure the safety of enterprise water security and urban water environmental system security.

Keywords: Dairy industry, DPSIR, Water footprint, Water risk

Trends of water and energy consumption with socioeconomic transitions in Jing-Jin-Ji region of China

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Abstract:

Water and energy are basic resources for production and daily life. With rapid economic growth and associated socioeconomic transitions in Jing-Jin-Ji region (including Beijing, Tianjin and Hebei), the increasing demand for water and energy bring severe environmental challenges for the region. Hence, understanding how socioeconomic transitions impact on water and energy consumption and discover the nexus between water and energy consumption with the transition are critical important for sustainable water and energy consumption. By using a comprehensive analysis framework based on input-output analysis and structural decomposition analysis, this study evaluated how the socioeconomic transitions, especially the industrialization and urbanization process in the Jing-Jin-Ji region, impact on water and energy consumption during the 2007-2012 period.

The result shows that water consumption declined slightly but energy consumption increased by 34% during the 2007-2012 period. Both water and energy consumption in the three provincial regions presented distinctive patterns, given to their different socioeconomic transition period. From industrialization perspective, service was the leading contributor for water (103% in 2007 and 109% in 2012) and energy (115% in 2007 and 85% in 2012) consumption in Beijing. Light manufacturing (106%) and construction (64%) was respectively the main water and energy consumer of Tianjin in 2012. Rapidly development of service in Tianjin promoted increase of water and energy consumption by 46% and 62%, respectively. 82% of water consumption in Hebei was induced by Agriculture and light manufacturing in both two years. Hebei was the only net exporter of water and energy in 2007, but avoided much water consumption in 2012 by shrinking exportation of agricultural products (42.1 trillion tons). Production structure change brought increments of water (0.6 billion tons) and energy (24.7 million tce) consumption in the Jing-Jin-Ji region, in which construction and consumer service promoted much energy and water consumption in Tianjin and Hebei.

For urbanization, increases in household consumption level, urbanization rate and population scale were the main drivers for water and energy consumption. Both investment and urban household consumption led to reductions in water and energy consumption in Beijing, while increased much in Tianjin and Hebei. Investment in construction accounted for 59% and 77% of water and energy consumption in 2012 in the Jing-Jin-Ji region. Urban household consumption on food was always the main source of water consumption (72%~73%) during the 2007-2012 period.

Given to distinct dominated sectors for water and energy consumption, electricity,

heat and water supply, resource related manufacturing and mining played relatively important roles in both water and energy consumption. Electricity, heat and water supply in Tianjin and mining in Hebei notably presented higher linkages between water and energy consumption. These findings directed a starting point to save water and energy together.

By identifying key drivers of water and energy consumption and uncovering water-energy nexus, our study provided oriented insights in sustainable water and energy consumption for Jing-Jin-Ji region.

Keywords: Water consumption, Energy consumption, Nexus, Input-output analysis, China

Sustainable development framework design for small-scale mining in the Amazon

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Abstract:

The challenge to promote sustainable development in small-scale mining is to exploit the mineral resources in a rational and conscious way, enabling the socio-environmental evolution of the regions involved. Recent research shows that this activity can be the major source of income for local populations in several mineral provinces in the world, both in terms of direct jobs for the miners and of indirect jobs for the community. This situation is more pronounced in small-scale mining areas of precious metals, especially gold. This article analyzes the environmental impact associated with small-scale gold mining (ASGM) in three separate locations in the Amazon, in order to understand the drivers associated with the sustainable regional development expectation of the communities. The areas studied are Tapajós, Xingu and Canaã dos Carajás, in the state of Pará, Brazil. Based on the consultations carried out with the populations involved, this article proposes the development of an innovative framework for evaluating regional development associated with small scale gold mining. The framework design will take into account the environmental, social, technical and organizational perceptions and expectations of the parties involved, incorporating ASGM-specific operational performance indicators associated. The result of the application of the framework to the areas studied is a plan of action involving joint initiatives between local leaders, governmental authorities and the productive sector. A critical aspect for this plan of action is the increase in awareness of the critical role of proper governance for the success of small-scale mining associated with sustainable regional development.

Keywords: Amazon, Small-scale Gold Mining (ASGM), Sustainable development, Socio-environmental, Regional development framework design

Development of a circular economy framework for recycled plastic value chain

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Abstract:

In Taiwan, waste generated amounted to 7.4 million tons in 2016, in which plastic waste occupied the share of 16.61% and contributed to the third place among all kinds of wastes. There are many limitations and deficiencies in the treatment of large amount of plastic waste due to its difficulty of decomposition, thus resulting in a heavy burden on the environment. Therefore, constructing a circular economy system for plastics and putting plastic waste back to the market for producers and consumers has become a priority of governmental governance. The objective of this study is to establish a viable development framework and pathway for plastics to move toward circular economy for industries. Base on the principles of circular economy, the efforts are focused on the construction of the platform for innovation and cooperation by integrating design, technology, business and service model to form the reverse logistic and recreate the value of recycled plastic, facilitating the enhancement of the value chain for the plastic industries. The significance of circular economy is to maintain the highest value of the materials at various stages of the life cycle through various circular paths and to use their products value to create new service values. Five kinds of circular business models, including circular supplies, resource recovery, product life extension, sharing platforms as well as product as a service will be planned; and the procedure of status assessment, opportunity identification, and business model evaluation for a selected plastic product will be implemented in the platform in order to develop and demonstrate the step-by-step viable framework of recycled plastic for markets promotion.

Keywords: Circular economy, Recycled plastics, Value chain, Reverse logistic, Platform

Critical assessment of the eco-industrial parks (EIP) program in China and Korea towards strengthening the EIP program in Vietnam

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Abstract:

The current era has emerged in ensuring resource recovery due to a significant decline in both quantity and quality of the natural resources. Materials, water, and energy that are regarded as unproductive by one company can be transformed into a prospective business opportunity through industrial symbiosis. Henceforth, the transformation of a general industrial parks into an eco-industrial parks (EIPs) is one of the popular sustainable industrial policy all over the world. Though the concept of industrial symbiosis and EIP policy is very simple and obvious, many advanced and developing countries have not yet produced much demonstrational EIP cases due to huge gaps between theories and practices as well as policy and execution. Thus, to apply the EIP policy, there is a need of a full understanding in the economic, socio-economic institution and technological context. To date, Asian countries like Korea and China have already implemented EIP with different pathways based on their contexts. This study aims to investigate the adopted policies, operational system, and monitoring method as well as achievements and limitations of both countries' EIP program. This is to draw out lessons learnt to strengthen the Vietnamese EIP program, which has just been started with the support of UNIDO and IFC. The results of this study will be used to customize the EIP program to Vietnam context from the achievements and limitations from both countries and overcome the barriers and support a suitable EIP development in Vietnam.

Keywords: Eco-industrial parks, Industrial symbiosis, China, Korea, Vietnam

Locus of control: Motivating pro-environmental behavior in China

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Abstract:

In the last decade, the slow green movement in China traces back to the inefficient collaboration between government and consumers: 34% of Chinese consumers are identified as eco-bystanders who mostly believe in the ineffectiveness of their personal activities (Chan, 2000). Previous studies strongly recommended to strengthen Chinese consumers' confidence in their abilities to affect environmental changes. Environmental locus of control (ELOC) investigates people's perceptions of controlling an environmental event (Cleveland, Kalamas, & Laroche, 2012; Kalamas, Cleveland, & Laroche, 2014). If people have a strong internal locus of control (IN-ELOC), they rather think that their actions (as [a]: green consumer, [b]: activist, [c]: advocate, [d]: recycler) can cause changes of the environment. In contrast, people with strong external locus of control (EX-ELOC) believe that rather external institutions or powers ([a]: governmental responsibility, [b]: corporate responsibility, [c]: higher power, [d]: natural earth cycles) can cause significant changes. Existing literature on the transitioning towards sustainable production and consumption in China considers the effectiveness of governmental regulations (e.g. Schroeder, 2014), the barriers for the institutionalization of organic labelling schemes (e.g. Dendler & Dewick, 2016), and psychological variables such as values, attitudes and social norms (e.g. Thøgersen & Zhou, 2012). However, consumers' perceived internal and external ELOC have not been analyzed as influencing factors for pro-environmental behavior (PEB). Addressing this research gap, this study is supposed to investigate the interrelationships between ELOC factors and PEB among Chinese consumers.

Moreover, a shortcoming of previous research is that internal and external ELOC have only been analyzed in separate studies. To be able to compare the effects, our model integrates both internal and external ELOC factors. Kalamas et al. (2014) proposed that there is a positive relationship, i.e. that consumers are willing to accomplish their own contribution, while they also allocate responsibility to powerful others. However, most of China's environmental conservation actions are led by the government which may reduce the perceived consumer responsibility. Thus, for the Chinese context, we expect a negative correlation: the higher the level of EX-ELOC, the lower the level of IN-ELOC. With regard to the influence of ELOC on PEB, we expect to confirm the positive effect of IN-ELOC and a negative influence of EX-ELOC: For example, if consumers delegate pro-environmental actions to government and corporations, they will be less likely to engage in PEB.

Further, our model tests the moderating effect of Confucian values. We expect that

for people with strong Confucian values, such as group orientation and reverence for authority, the negative effect of government and corporate responsibility (EX-ELOC) on PEB will be more pronounced, while the positive effects of IN-ELOC will be weaker. A structural equation model will test the effects between the latent variables and the moderator. Using an online survey, 400 usable questionnaires will be collected in Beijing by March 2018.

References are available upon request.

Keywords: China, Environmental locus of control, Pro-environmental behavior

Valorization of waste foundary sand and fly ash using geo-polymer concrete technology

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Abstract:

This paper investigates the potential valorization of waste foundry sand (WFS) and fly ash using geo-polymer concrete (GPC) technology, which can reduce the construction materials dependency on the depletion of natural resources. Ground granulated blast furnace slag (GGBFS), fine aggregate, coarse aggregate, fly ash, an alkaline solution and water was used to form GPC. A D-optimal mixture design was utilized by varying fine aggregate (30–55 wt%), foundry sand (15–40 wt%) and fly ash (20–30 wt%) to characterize the structural and environmental performance of GPC as a construction material. Structural performance was measured by compressive strength and scanning electron microscopy (SEM) and energy dispersive X-ray diffraction (XRD), while environmental performance was measured by the leaching concentration of heavy metals from GPC. Results indicated that the optimum compressive strength of GPC was 19.0 N/mm^2 (7th day) and 22.2 N/mm^2 (28th day) from the optimal mixture percentage of 51.9wt% fine aggregate, 24.8wt% foundry sand and 23.3wt% fly ash was higher as compared to conventional concrete having compressive strength of 16.5N/mm^2 (7th day) and 18.5N/mm^2 (28th day), respectively. Leaching test on the solidified GPC specimen achieved 98-100% heavy metals immobilization. These results ascertained that foundry sand can be valorized as an eco-friendly construction material in GPC by the substituting raw materials which results to a cost and carbon emission reduction.

Keywords: Geo-polymer concrete, Heavy metals immobilization, Valorization, Wastes foundry sand

Achieving sustainable development goals in mining enterprises within communities impacted naturally by mineral deposits: A discussion of the oil sands of Nigeria

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Abstract:

Mining activities have been known for their impacts on the environment but considering the oil sands deposit located in Ondo state Nigeria, there is an exception due to the fact that the local communities are naturally impacted by the oil sand deposits without any ongoing mining activity. Hence, it may be challenging to measure sustainable development using UNDP Sustainable Development Goals (SDGs) in this scenario. In some parts of Nigeria, the exploitation of natural resources such as petroleum may be perceived as a curse to the country rather than being a blessing. Recent research and past experiences within the oil and gas industries show that this situation is more pronounced in the southern part of the country near Ondo state. Inability to promote sustainable development in the region has brought the awareness that the mining industries must be more focused on achieving the SDGs in a practical sense. This research aims at developing a strategy on how these goals can be achieved especially where the natural impact of the oil sands deposits on the communities is to be considered. The methodology applied includes interviews carried out in the study area, appraisal of the questionnaire proposed to the community, strategy development and considerations of alternative approaches for compensation in case of relocation. The outcomes of the interviews are analysed to evaluate the impact of the SDGs in the communities considering the implementation of mining activities in the region and the fact that the communities are also naturally impacted by the mineral deposits. The resultant strategy will serve as a guide for mining industries to ensure sustainable mining operations in areas that are naturally impacted by mineral deposits and areas that are not.

Keywords: Oil sands deposits, Ondo state Nigeria, Sustainable Development Goals (SDGs), Naturally impacted communities, Mining activities

Revisiting the sustainability of cultivated land use in China: Grain safety vs. ecological security

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Abstract:

This paper aims to provide new insights into assessing the sustainability of cultivated land use in China by combining the dual perspectives of grain safety and ecological security. To that end, the approach to grain supply-demand balance is employed to measure the gap between production and consumption of grain at both national and provincial scales, and the ecological footprint analysis is undertaken to determine whether the cultivated land use in China is ecologically sustainable or not by comparing the ecological footprint with corresponding biocapacity. The results are presented in a comparative sense. First, there is substantial geographic displacement of cultivated land use in most parts of China. Provinces in the central and northeast are likely to be in surplus whereas those in the southeast tend to overshoot. Second, China as a whole has long been operating in a state of ecological overshoot, especially for those of provinces in central and east China. However, a few exceptions can be found mainly in south and southwest China. Third, we find the discrepancy between the outcomes of the two approaches to be remarkably large, suggesting that they are complements to, not substitutes for, each other in assessing the sustainability of cultivated land use. Furthermore, we make preliminary attempts to define the safe operating space for cultivated land use in China. Following the planetary boundaries framework arguing that the maximum permissible percentage of global land cover converted to cropland should be well below 15%, the upper limit of China's cultivated land amounts to 144 million hectares. Together with the red line of cultivated land protection to which China has determined to stick, the safe operating space for China's cultivated land use can be estimated to be ranging from 120 million hectares to 144 million hectares. Nevertheless, we realize that this is a very rough estimation, and thus requiring further exploration. In view of the increasing inter-provincial grain trade, the virtual appropriation of cultivated land resources among different provinces should be taken into account in future research. In conclusion, although overall China's cultivated land reserves can support its population to large extent, the use of cultivated land in recent years continues to be in an ecologically unsustainable way. These findings highlight the need for a simultaneous assessment of grain safety and ecological security, which is the key to understanding the sustainability of cultivated land use from a broader point of view. This study also serves as a starting point for discussions on both upper and lower limits of cultivated land use, which has nevertheless been a neglected field of analysis in resource sustainability debate.

Keywords: Grain safety, Ecological security, Cultivated land, Supply-demand balance, Ecological footprint

Accounting for ecosystem service losses of products in China by combining emergy and input-output analysis

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Abstract:

In an attempt to improve the sustainable development of production activities, the ecological costs must be accounted for from the whole life cycle perspective. Besides consuming resources, production activities inevitably alter the structures and functions of ecosystems, leading to ecosystem service (ES) losses. The ES losses should be involved in as a virtual cost of production activities. To quantify the ES losses in the life-cycle of products, this study proposed an eco-thermodynamic input-output model of the 2012 China economy by combing input-output technique and emergy method because emergy can facilitate unified different ES identified by the Millennium Ecosystem Assessment. The results showed that the total ES losses caused by the national economy activities in 2012 were 1.26E+24 sej. The sector of forestry is found to have the largest ES losses intensity of 2.15E+16 sej/1E+4 CNY among all sectors. Correspondingly, the sectors of paper products and rubber which are closely related with forestry had high ES losses intensities. The resulted database can provide a basis for the further analysis of overall ecological costs of production activities at various levels, and it is useful to identify opportunities for improvements in their ecological sustainability.

Keywords: Products, Ecosystem service losses, Emergy, Input-output analysis

The lead-lag relationship research of steel products in different regions

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Abstract:

There exist different steel products in steel industry chain, their prices are related tightly. And as a major material in global economy flows, prices of different steel products in different regions are related, too. In order to study the relation of different steel products in different regions, we use wavelet cross correlation method to calculate the lead-lag relationship of different steel products prices in different regions and construct the two-mold price lead-lag relationship network. The result shows in short term period, steel products prices in each region differs a lot and in long term region, steel products present the same fluctuating features.

Keywords: Lead-lag relationship, Steel industry chain, Two-mold network

Comparison of eco-industrial park monitoring methods by deductive and inductive approach

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Abstract:

Eco-industrial park (EIP), new and in transition, can be defined as a dedicated area for industrial use at a suitable site that ensures sustainability through the integration of social, economic, and environmental quality aspects into its siting, planning, managements and operation. There are currently a number of complementary tools to assist governments and industrial stakeholders to monitor the performance of EIP activities. In order to track the performance enhancement of EIP, various indicators such as resource reduction, energy saving, waste reduction, revenue and job creation and eco-efficiency enhancement by industrial symbiosis network expansion are calculated, as the improvement of EIP must be compared to baseline year, when EIP program is not operated. However, to get all the reference data in the monitoring reports of the industrial complexes are very difficult and time consuming. These are essential for policy and decision makers that have not yet been produced much. Therefore, this study is to propose a very simple and practical EIP performance monitoring method by theoretically comparing the traditional deductive and newly proposed inductive approach. The traditional EIP monitoring method to measure the performance follows a deductive approach, which immediately accounts the separate data of the total resource, total energy and total waste of all the companies. This has a drawback of numerous data collection and a difficult start-up tracking step. The proposed method to measure the performance in this study is through an inductive approach to monitor the industrial activities. This method account first for the companies that are interested in doing an industrial symbiosis type of activities. This would have an advantage of minimizing the administrative work of data gathering which translates to less time-consuming tracking work load, better communication with stakeholders and decision-makers. Both deductive and inductive approach would draw out the same final performance result. A theoretical example is in 10 companies, which have two resources per company, and produces a product and waste (1 time tracking per year for 9 years). If the waste would be accounted to a resource in another company, the traditional deductive approach accounts for the efficiency as 1/20, 2/20, 3/20, … 9/20. For this study, the inductive approach accounts for an initial of 2 willing companies and an annual addition of 1 company per year for 9 years. The efficiency would result to 1/4, 2/6, 3/8, … 9/20. Hence, the inductive approach of this study would effectively track EIP activities at a more practical method. This would thus be beneficial in attracting businessmen towards an efficient tracking approach for EIP related activities.

Keywords: Eco-industrial park (EIP), Deductive approach, Inductive approach, Industrial symbiosis, EIP performance monitoring method

Environmental benefit evaluation of clean power transition in China: Jing-Jin-Tang case

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Abstract:

As China enters a new area, China is actively seeking to implement transition development, especially green development, aiming at promoting economic and social development as well as reducing harm to the environment. Given that China's power sector dominated by the coal-fired power which contributes considerable amounts of greenhouse gas (GHG) and critical air pollutants (CAPs) emission, China is increasing its efforts to promote the clean power transition in China, including developing gas coal-fired power and renewable energy power. Based on a summary of the characteristics of energy consumption, related GHG and CAP emissions in China's power sector, this paper developed an analysis framework and established related evaluation methods to quantitatively evaluate the environmental benefit in terms of reducing GHG and CAP emissions from clean power transition in support of green and sustainable development in China. As a typical region with significant contribution to GHG emissions and severe air pollution, Beijing-Tianjin-Tangshan (Jing-Jin-Tang) region is taken as an example to demonstrate an application of the proposed framework and methods to assess the environmental benefit of China's clean power transition. The results indicate that the clean power actions proposed in this paper would result in emission reductions of approximately 10 thousand tons (Tt) of CAPs and 8 million tons (Mt) of GHG in 2016. By 2020 and 2030, emission reductions of 16 Tt of CAPs and 11 Mt of GHG and of 34 Tt of CAPs and 24 Mt of GHG, respectively, will be achieved. The proposed model can effectively help China's central government and regional government identify the emissions reduction effect of the clean power transition and support the development of policy describing the next steps for tackling climate change and haze pollution. The proposed model in this paper is also beneficial for countries similar to China in their efforts to promote the transition of power sector to supply more clean power.

The most important innovations of this paper are mainly reflected in: (1) establishing a simple and practical analytical framework and related evaluation methods focusing on quantitatively evaluating the environmental benefit of clean power transition in support of green and sustainable development in China; (2) taking Jing-Jin-Tang region as a case to demonstrate an application of the proposed framework and methods based on different power structure scenarios; and (3) from an international perspective to help countries similar to China make decisions on implementing actions aimed at promoting the transition of power sector.

Keywords: China clean power, Environmental benefit, Climate change, Air pollution,

Jing-Jin-Tang region

Life cycle costing of construction and demolition waste recycling for cost-effectively building retrofits -- A case study in the Netherlands

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Abstract:

Gradually aging and a lack of adaptation and flexibility of buildings often lead to destructive interventions, resulting in not only financial tightening, but also resource depletion and waste generation. Recently, a cost-effectively and environmentally sound innovation system (Ref. VEEP project) has been developed to recycle of CDW into high value-added and energy-efficient prefabricated concrete panels (PCP). Those panels will be conceived both for new building envelope (PCP1) and for building envelope refurbishment (PCP2). The objective of this study is from an economic perspective to identify to what extent we can financially benefit from this novel technology during the life cycle of a building unit, based on the primary data collected from an exemplary four-storey residential building in the Netherlands. Previous studies have proven Life cycle costing (LCC) to be a powerful tool for evaluating the costs of the whole cycle, especially at building level. By using a LCC approach in this research, two PCP renovation scenarios and a business-as-usual (BAU) scenario are simulated, and then the benefits and drawbacks of different scenarios are evaluated focusing on the life cycle of the target building. The comparative results reveal that the PCP solutions have the potential to reduce a quarter to half of the life cycle cost as compared to BAU, depending on the type of the building (new/existing) and duration of retrofits. Most savings come from the avoided transport of CDW by using an advanced on-site recycling system and the reduced heating expense during building operation.

Keywords: Life cycle costing, Building retrofits, Energy efficiency, Construction and demolition waste recycling

Evaluation of the compressive and shear strength of brick masonry walls retrofitted with recycled polyethylene terephthalate (PET) strips

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Abstract:

Retrofitting of historical structures not only requires in-depth engineering studies but also amount to millions of pesos. Most historical structures are of masonry material such as bricks or stones. These structures are mostly designed by considering gravity loads and minimal to no consideration of lateral or earthquake loads. Thus, most priceless historical structures fail during earthquakes. The use of polyethylene terephthalate (PET) bottles is an alternative retrofitting material promoting sustainable development. PET is known for its strength, toughness, lightness, and its ability to act as barrier to liquid and gas. The use of recycled materials such as PET bottles will decrease the overall cost of retrofitting projects as compared to those typically practiced today. In addition, this method contributes to the reduction of plastic waste which is a prominent problem of today. Brick walls (400x400x75mm) shall be fabricated and retrofitted for the conduct of the experiment. Walls shall be retrofitted by confinement with strips arranged in mesh fashion. The center to center distance of one PET strip to another, or pitch, shall have three deviations. The three pitch distances used for the mesh arrangement shall be: 40mm, 50mm, 75mm. ASTM standards D882, E519M-15, and C1314-16 shall be followed for the tensile parameters of the PET strips, shear strength determination, and the compressive strength determination, respectively. A total of 24 walls shall be fabricated. The increase in the compressive and shear strength of PET strips retrofitted walls shall then be taken from these tests. To evaluate if there is significant increase in the compressive and shear strength of the retrofitted walls, the t-test statistical tool will be utilized. The same method shall also be used to evaluate the effect of each pitch distance.

Keywords: Retrofitting, Historical structures preservation, Sustainable development, PET bottles recycling methods, Waste utilization, Brick masonry walls

Accurate analysis on urban water-carbon nexus using disaggregated input-output model

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Abstract:

Accompanying with the blossoms of rapid urbanization and industrialization, urban has become a highly concentrated area for production and consumption activities. The water resource limitation and carbon emissions originating from fuel combustions are two important bottlenecks for high-speed urban economic development. How to adapt to the development and transformation of cities under various resource and environment constraints, such as water resource and carbon emissions, has become the core management objective for the current cities. Accordingly, accurate analysis on urban water-carbon nexus is becoming vital for the development and transformation in the future of urban system and the necessary precondition for the sustainable development of urban system. However, there are two problems in the existing researches on water-carbon nexus of urban systems: On the one hand, the limitation is that previous studies only focused on water consumption in energy subsystems, energy consumption and carbon emissions in water subsystems; On the other hand, in the rare studies on water-carbon nexus in urban economic system using the input-output method, the classification of industrial sectors is awfully rough, for instance, the construction sector cannot be subdivided into various types of buildings. The corresponding results with rough sector classification are difficult for the policies to be effectively implemented in cities. Therefore, in this study a WC-IO-LCA model was constructed based on modified Input-Output method by disaggregating the key industrial sector refinely into subsectors. The constructor sector as the main consumption-based contributors of water and carbon emissions was selected as the case to be disaggregated into 12 subsectors according to the different building types in cities. With this model, the water-carbon nexus is accurately analyzed in urban economic system and the key node for nexus is identified. It can help increase the knowledge and understanding

about the water-carbon nexus in urban industrial system and can help policy makers formulate executable and feasible policies and measures.

Keywords: Disaggregated IO analysis, Building, Urban water-carbon nexus, Embodied

Where will the waste plastics refused by China go?

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Abstract:

China has been a major processing center of waste plastics for many decades, with imported plastics recycled to provide raw materials for manufacturing sectors. In 2016, more than 7.3 million metric tons of waste plastics were imported into China, valued at $3.6 billion. In addition, the largest sources of waste plastics, including European countries, Japan, and the United States are heavily reliant on China's recycling industry. However, China notified the World Trade Organization in July 2017 that it would impose a ban on the import of 24 types of solid wastes in four classes, including polyethylene, polystyrene, polyvinyl chloride, and other types of plastics in the beginning of 2018. Where to dispose the extra waste plastics from those developed countries is therefore a big issue. The weight of waste plastics imported into China decreased from 2014 and declined to 5.8 million metric tons in 2017, which were equal to imports in 2006. We found that the weight of waste plastics decreased about 9%, which were exported by Europe, Japan and the United States, and increased which were imported to the Southeast Asian countries from 2013 to 2016. So, we make a primary conclusion that the developed countries will reduce waste plastics production and enhance disposal capability, and the Southeast Asian will be a new waste plastics processing center from 2018.

Keywords: Waste plastics, Export, Import, Plastic trade

Study on carbon footprint of the household expenditures in Beijing based on multi-scale input-output analysis

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Abstract:

In this paper we evaluate the relationships between household expenditures and carbon footprint by combining household expenditures with environmentally extended input–output analysis. Expenditure elasticities are examined with regression analysis, and are compared and interpreted on the basis of insight at the product level. Given that Beijing is a highly open system, most consumer goods are imported and imported, the method of multi-scale input-output analysis is applied in this paper. With data from Beijing in the year 2012, we find that carbon footprint increases with increasing household expenditures, although the degree to which the carbon footprint increases differs different product groups. It appears that the mix of necessities and luxuries to which carbon footprint is related is essential in explaining the relationship. The research outcomes from this study can also facilitate decision makers in other provinces to mitigate the overall carbon emissions from their household sector by considering their local situations.

Keywords: Multi-scale, Input-output, Household expenditures

An efficient heat recovery system in Swedish low-energy multi-family buildings

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Abstract:

Mechanical ventilation with heat recovery system (MVHR) has shown promising improvements in reducing ventilation heat loads especially in countries with long heating seasons. This paper investigates the potential of alternative heat recovery systems in reducing peak-load heating demand. The ventilation heat demand of a residential multi-family building in Stockholm has been examined as the case study. The study is based on TRNSYS simulations of the building model equipped with the suggested heat recovery systems. Simulation models of the building and the heat recovery systems are verified against field measurements.

The building equipped with MVHR is studied as the reference case. A novel wastewater heat recovery system is designed and analyzed based on the daily average water consumption by a person in Stockholm. The released wastewater from the building is accumulated in a temperature stratified storage tank and is used as a heat source to preheat the incoming air to the MVHR. The efficiency of the rotary heat exchanger at MVHR is also determined as a function of inlet fresh air temperature to the heat exchanger.

The annual simulation results compare the energy performance of the studied systems as well as the peak heat load reductions. The suggested wastewater heat recovery preheater combined with MVHR increases the coldest inlet ambient temperature to the MVHR from -19.7°C to -11.8°C. Preheating the incoming air to the heat exchanger will decrease the peak power need and the possibility of frost formation at the heat exchanger. The annual energy analysis, however, does not show reductions in energy demands. The reason is the fact that the heat exchanger efficiency is reduced as the temperature of the incoming air to the MVHR is increased by the preheater. The wastewater heat recovery system can also be used in order to post-heat the supply air to the building after MVHR. This configuration shows the potential to reduce the annual heating energy demand.

Keywords: Waste heat recovery, Power and energy savings, Mechanical ventilation with heat recovery, Swedish low-energy buildings

A Bayesian belief network approach to assess integrated ecological impacts: Case study of Kunming City, China

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Abstract:

The ecological impacts of human activities are complicated and interrelated at a regional scale. However, most existing impact assessment methods and management practices mainly focus on some specific resource or environmental impacts, such as water resource shortage or air quality pollution, ignoring the integrity of ecosystem. The integrated regional ecological impacts should be assessed to uncover potential trade-off among different ecological protection objectives.

Taking Kunming City, China as a case, we established a Bayesian belief network (BBN) model to analyze the integrated impacts of human activities on regional ecosystem. In this model, the whole regional ecosystem was conceptualized as structures, processes and services while the human development activities inside the ecosystem boundary were described as multi-level driver and stressor indicators. A 11-year time series dataset (2000-2010), including 146 regional development and ecological variables, was used for parameter learning of the BBN model. Missing data were elicited by expert knowledge. Data in 2011 were used for model validation. The proposed BBN model can not only quantitatively assess the integrated ecological impacts, but also reveal key influencing factors, which effectively supports the ecosystem-based management.

We then applied this model to assess 7 ecosystem services during 2000-2010 in Kunming City and predict the status of these ecosystem services in 2020 under a given development scenario. Results showed that air purification, soil erosion and water regulation services were continuously improving. On the contrary, habitat provision, water supply and food supply services were showing a rapid declining trend. Water purification service is very likely to worsen in the future, which should be paid more attention to.

We further investigated the mechanisms how human activities affected ecosystem services, which ecological components were most vulnerable and what human activities contributed most to different ecological impacts. Taking water regulation service as an example, results showed that, among all regional development activities, Grain to green project (GTGP) and afforestation contributed most to the increase of water regulation service in Kunming during 2000-2010. Precipitation, forest canopy closure, and grassland area had the most significant effects among all ecological factors. When these variables shifted from low value state to high value

state, the probability of water regulation service in high state (44-54 billion ton) increased by 5.1%, 4.5%, 96.1%, 7.9%, 5.1%, respectively. The recovery of vegetation fractional cover in Kunming attributed to large-scale GTGP and afforestation, was the main mechanism for the constant improvement of water regulation service. Finally, the implications of our findings to Kunming's ecosystem management policies were discussed.

Keywords: Integrated ecological impact, Bayesian belief network, Ecosystem service

Profiles of in-use wastewater treatment infrastructure stocks in Chinese national industrial parks

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Abstract:

China has a large number of industrial parks, among which 626 parks are national-level parks. The national-level industrial parks have been playing a crucial role in facilitating urbanization, modernization, and economic development. However, they are also generating intensive pollutants. Wastewater treatment plant (WWTP) is a kind of widely-employed infrastructure in industrial parks to tackle the intensive environmental issues in industrial parks.

We carefully studied the profiles of in-use WWTPs stocks in more than 200 national-level industrial parks in China, including their vintage, capacity, capital investment, energy consumption, operating cost, and removal efficiency of 17 categories pollutants. We found that there was a peak of WWTP construction around 1992 and a peak of upgrading from provincial parks to national parks around 2009-2010.

Among the 217 national-level industrial parks, 156 parks have centralized WWTPs in their geographical boundary with a total number of 347 in-use utilities and a total treatment capacity of 18 million ton wastewater per day. The average loading rate of the in-use WWTP is 74.4%. The specific investment ranges from 147.5 CNY/t to 1755CNY/t due to different treatment process. The operation energy consumption ranges from 0.1 kWh/t to 2 kWh/t, and the operating cost ranges from 0.22 CNY/t to 15 CNY/t. The effluent quality of the WWTPs was carefully examined. More than 53% of the WWTPs implemented the class A emission standard and 34% WWTPs implemented the class B standard. Against the challenges associated with the forthcoming request of improving discharge standard, the technic-economic feasibilities of WWTP upgrading were assessed, and the policy implementation was also discussed.

Keywords: Wastewater treatment plant, Industrial parks, Stocks, Performance assessment, Cost benefit analysis

Comprehensive PVC material flow analysis and its environmental impact assessment in China

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Abstract:

Plastic has become one of the most commonly used materials worldwide. Polyvinylchloride (PVC) is one of the general plastic /synthetic resins and is widely used in various applications, such as construction, packing and consumer goods. Around 60% of PVC produced in China has been used for construction among these downstream consumptions, and thus the PVC industry is directly related with China's urbanization and real estate industry. However, the production and consumption of PVC in China have brought environmental issues, such as fossil fuel consumption, and PVC waste accumulation. Therefore, it is indispensable to analyze the PVC stocks and flows in China and discuss the strategy scenarios to reduce the PVC waste accumulation and environmental impacts, in order to provide theoretical and technologic support for PVC life cycle management. Material flow analysis (MFA) has been used to set up a model for quantitatively analyzing the national PVC stocks and flows in China including production stage, consumption stage and waste management stage. A matrix has been developed to present the key findings of the overall environmental impacts of the PVC, according to its constituent processes, in these three stages. The database of PVC and the dynamic model have also been developed to calculate the accumulation of PVC waste from 1980 to 2050 in China. This study has systematically analyzed the scenarios based on the main factors including life expectancy, recycling technology, landfill/incineration, and prohibition of plastic waste import. The results suggest that the rapid development and consumption of PVC in China significantly bring waste accumulation and impacts the environment. The impacts at the production stage and waste management stage dominate the total impacts of the PVC industry. The rapid development of the PVC industry has indirectly stimulated the development of the coal, crude oil and other raw material industries, which further increases the pressure on the domestic environment. With respect to the potential alternatives in 2050, a scenario analysis suggested that a rational growth of the PVC industry is highly desirable to mitigate the increased environmental pressures. Advanced technologies to reduce the demands for materials and pollutant emissions are required at the production stage to diminish the impacts. Increasing life expectancy, improving recycling technology, and enhancing recycling system would be helpful to achieve the goals of energy saving as well as pollution reductions.

Keywords: Polyvinylchloride (PVC), Material flow analysis, Production stage, Waste management

Mapping the role of policy instruments in industrial symbiosis intrinsic/endogenous practice with a conceptual framework based upon producers' perspective: A comparison between UK and China

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Abstract:

Industrial Symbiosis (IS) can be a powerful sustainable business concept for achieving sustainability and generating significant revenues. It does this by using one factory's waste as an input to another factory. The uptake of IS is, however, less extensive than it could be. From the policy perspective, this may result from the 'top-down' approach of IS implementation in which little innovative flexibility is left to operators for seeking material exchange and resource reuse, like in China; or the 'bottom-up' approach, by which the collaboration between firms in the free-market for building IS synergies is largely impinged by the dissension between the expectations of government and the interests of local businesses, like in the UK.

This study seeks to study both countries' experiences in implementing IS from the policy perspective. The primary research question is what policy worked well under what conditions, and what did not work well under what conditions in fostering IS practice in UK and China. To answer this question, this research stands at the philosophical position of interpretivism, and applies qualitative research methods.

Before this, a literature and practice review and pilot interviews were conducted to help build a conceptual research framework. Based upon this framework, a qualitative research was conducted through carrying out one pair of comparative case studies under one of the most typical IS Fostering Models – the Intrinsic/Endogenous IS Fostering Model in each country of UK and China. Ten policy instruments were analysed across UK and China, which resulted in the identification of how each of the ten policy instruments worked well or not under what conditions, and the similarities and differences between UK and China.

Keywords: Industrial symbiosis, Industrial ecology, Policy instruments, Endogenous practice

Is China's River Chief Policy effective? Evidence from a quasi-natural experiment in China's Yangzi River Economic Belt

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Abstract:

The rapid industrialization and urbanization process have inevitably brought about serious water pollution, which force the Chinese government to design and practice a brand new water control system- River Chief Policy (RCP) to cope with it. Employing the difference in difference method (DID) and the panel data of 40 cities in Yangzi River Economic Belts during 2004-2015, this paper explores the impact of RCP on surface water pollution. The results show that: (1) the RCP materially improved the water quality. However, the effect of RCP level off after three years of its implementation. (2) the variables of industrial wastage, living sewage have been sharply reduced after the RCP adoption, while the decrease of fertilizer usage and the increase of technology turns out not be significantly, meanwhile, the variable of government supervision increased rapidly, which indicating the stringent control on industrial and living sewage might be the possible channels of RCP, while agriculture sector has still lack of supervision and technology innovation make little progress during post-RCP period. (3) the effect of RCP is more obvious in cities with a higher GDP level and higher government transparency than cities with a lower average GDP level and lower government transparency. Lastly, this paper gives some policy implications for future RCP.

Keywords: River Chief Policy, Water pollution, Effect

The analysis of spatial distribution of process gases within a pile during composting of bio-waste

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Abstract:

Limited public awareness and recent increase in consumption contribute to excessive exploitation of natural resources and modification of environment, which includes production of larger amounts of waste. Bio-waste production is an inherent part of that process. In new fields of activity bio-wastes are considered as secondary resources. The most common method of bio-waste management is bio-processing under aerobic conditions (composting). Composting processes result in the reduction of weight of waste intended for landfilling, and give a product that may be used as an organic fertiliser in farming. The major gases contributing to bio-degradation of organic matter are methane, carbon dioxide, hydrogen and oxygen. Other gases, such as nitrogen compounds, volatile organic compounds, carbon monoxide and hydrogen sulfide are also produced quite frequently. Quantitative detection of gases emitted to the environment is important, considering the development, and implementation of composting technologies and the improvement of emission models. Availability of quantitative data concerning greenhouse gases emissions from composting farms may improve accuracy of data concerning the emissions listed in national and international databases.

The analysed bio-waste (tree branches, grass and sewage sludge) were composted in six piles with passive aeration including additional turning from July to December 2017. Piles differed in turning regime (no turning, turning once a week and turning twice a week), location (outdoor, and indoor the composting hall). Using a probe with electrochemical analyser and thermocouple connected, the chemical composition and temperature of process gases within the piles were analysed weekly. During one measurement cycle 28 samples were collected in specified locations from single pile (considering both sides of the pile; 1/5, 2/5, 3/5, 4/5 of pile length; 3 heights, including one deep location). The analysis also encompassed the weather effect (different seasons of the year, piles located outdoors or inside a composting hall) on the course of variations of temperature and composition of process gases within the piles, as well as the results of the composting process, including variations of moisture content, organic matter content and respiration activity.

On the basis of the measurements and the obtained results pile aeration degree, temperature regime as well as CO, CO_2, O_2 and NO concentration spatial distribution

variations during following measurement cycles have been visualised.

Higher CO and CO_2 concentration was observed mainly in piles stored outdoors during the summer period, however an upward trend was determined after turning of the material (110 ppm CO, 13% CO_2). The highest variations in NO concentration were determined in piles that had not been turned. They were characterised by low initial concentration (1 ppm) that increased during the final stages of the process (22 ppm), as an effect of developing nitrification.

Keywords: Organic waste, Composting, Carbon monoxide, Spatial distribution, Turning pile

A research on the balance mechanism of stakeholders in land resources planning and management due to space planning reform in China

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Abstract:

Chinese government is working on the reform of space planning. The essence of space planning is to optimize the production, living and ecological functions under the carrying capacity of resources and environment. By optimizing the regional development model, the space planning is an important path to realize a coordinated development of economy, society and ecological environment. In this paper the authors believe there are interest conflicts in the game of enterprises and the government during the government's planning and enterprises are the actual stakeholders of the government's planning. The government's planning can ultimately affect economic activities. And the government in the game not only need to think of the development requirement of the main body but also need to think of the demand of provide public services in particular circumstances. Especially in the limited capacity of resources and environment the government need to balance the need of economic factors and environmental factors. However, the government's pursuit of economic factors and environmental factors may have interest conflicts with the pursuit of economic elements of enterprise. How to solve the conflict of interests between the government and enterprises is not only a resource allocation problem but also a game strategy. And because in the game between government and enterprises, there is a different allocation of a set of function in the different allocation of economic and environmental factors, therefore this paper built a hybrid game to analyze the profit distribution of the enterprises and the government in the allocation of resources in the land resources planning.

The results showed that from the point of government, when the enterprise hold a probability of 22% to choose to support the government the benefits was fixed. And when the enterprises chose to support the government's probability is less than 22%, the benefits of the government's function value would reduce with relies on probability of economic growth. On the contrary, the benefits of the government's function value would increase with the increase of economic growth probability. At the enterprise level, the value of the income function was increased with the enterprises supporting probability without regard to the government partial. That is to say for the government's spatial planning, in the process of balance the overall arrangement of production, living and ecological, whether the government relies more on the

environment benefit or the economy problem, as long as the probability of enterprise supporting above 22%, the government benefits will increase. But for the enterprise, whether the government in the spatial planning is more thinking about the economic development benefits, or more to consider environmental benefits, as long as the enterprises support government, benefits of the enterprise will always increase. Therefore, in making of space planning, not only the technical conflict and the coordination of various departments should be deal but also more consideration should be given to the balance of economy and environment, and a better coordination of the relationship between government and enterprises should be kept to get the support of enterprises in the planning.

Keywords: Spatial planning, Land and resources planning, Environmental benefits, Hybrid game

Research status of carbon emissions from the perspective of “urban-land-government”

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Abstract:

Low carbon development has gradually become an important strategic path for countries in the world to deal with climate change and achieve sustainable development. Based on the main carrier, the basic elements and the main body of the low-carbon development, that is a new perspective of urban-land-government, this paper reviews the current situation of the research on carbon emissions, and provides some reference for the relevant researchers or urban managers. Based on the collection and statistical analysis of the important international journals in 1985-2015, we have found that: (1) The interdisciplinary nature of carbon emissions determines that there are many types of journals involved, among which SCI journals are the majority, and the "land use and carbon emissions" as the subject of the majority of the literature. (2) The number of documents has a trend of accelerated growth. From 2006, the growth rate accelerated. (3) In the number of papers, the author's influence, the number of research institutions, developed countries are far ahead of developing countries. (5) There are a lot of literatures about “land use and carbon emissions” and “urbanization and carbon emissions”, the literature on government and carbon emissions is less, and there’s almost no research on "city land - based on the perspective of government". Research enlightenment: (1) The number of SSCI journals will increase rapidly with the perspective of multi dimension. (2) It is the only way for the development of the local research to draw lessons from the experience of developed countries and carry out practical cooperation with them.

Keywords: Carbon emissions, Urbanization, Land use, Government behavior, International journal, Review

Modeling and optimization to reduce irrigation impacts through re-wiring the U.S. domestic food trade network

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Abstract:

Virtual water trade refers to the trade of water that is not physically embedded but used in producing the traded commodity. Through virtual water trade, scarcely available water can be diverted for other uses by sourcing water-intensive food commodities from water-efficient or water-rich regions. Similarly, food trade and embodied impacts accounting provide numerous pathways of displacing resources and emissions associated with agriculture production. Thus, effectively structured trade can alleviate environmental impacts associated with food production and consumption. While reconfiguring trade requires consideration of diverse economic, social, and environmental factors, this work investigates impacts of irrigation associated water and energy resources on United States (U.S.) food production and trade. It is a common knowledge that food-energy-water systems (FEW) are intricately connected and require integrated management to avoid sub-optimal outcomes. As such, structural optimization of the embodied impacts of trade can reveal these interconnections and ultimately support in designing more sustainable and resilient food systems.

This work reconfigures domestic food trade in the U.S. to minimize irrigation impacts from a FEW nexus perspective and study resulting tradeoffs/benefits. Using publicly available data from Bureau of Transportation, we create domestic food trade networks consisting of 51 states and six major grains (corn, wheat, barley, sorghum, rice, oats). Combining data on irrigation water withdrawals, energy pricing, and type of pumping fuels used with life cycle assessment methods, we create three distinct networks of virtual irrigation water (virtual blue water), irrigation embodied energy and embodied greenhouse gas emissions. We rewire the network by keeping the food demand constant and evaluate a series of constraints pertaining to energy-water usage to understand whether production can be shifted realistically to optimize all three systems. For instance, can we simultaneously reduce sourcing food irrigated from water-scarce aquifers (e.g. Ogallala aquifer) and decrease dependence on states that utilize non-renewable fuel sources. Preliminary results of re-wiring domestic rice trade to reduce virtual water usage shows 27% water savings (15.1 billion m3 reduced to 11.1 billion m3). However, due to shifting in production to more water-efficient states, a 10% increase in marginal land use is required. The land results are significant as they demonstrate the resulting sub-optimal solutions when interdependencies are overlooked. On the other hand, minimizing groundwater usage from water-stressed areas also reduces overall greenhouse gas emissions demonstrating that these are not mutually exclusive goals in some states. The implications of model results including their potential and limitations for enhancing the

sustainability and resilience of the FEW nexus will be described in detail.

Keywords: Food-energy-water nexus, Trade, Networks, Optimization

Study the effect of pollution on an ecosystem: A thermodynamic perspective

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Abstract:

Urban ecosystem is critical to the purification and management of pollutants emissions in the process of urbanization. In this study, an emergy-based environmental impact assessment model is established according to the Eco-Indicator 99 for monitoring the negative effects on human health and ecosystem loss. This environmental impact assessment model is based on the urban sustainable development perspective, and emphasis the urban ecosystem services to reduce pollutants emissions and optimize pollutants management in the process of urbanization. It is vital that the links among ecosystem services, human health, ecosystem loss and urban sustainable development are comprehensively considered especially from the perspective of a donor-side. According to the limitations of existing emergy method, this model evaluates the ecosystem purification capacity to air, water and soil pollutants from the perspective of reducing the harms to human health and natural ecosystem. Beijing-Tianjin-Hebei area, as the national capital region of China and with ambitious targets for tackling pollutions especially air pollution and setting measures to reach these targets, is selected as study case to evaluate the ecosystem purification capacity to pollutants emission and optimize ecosystems' role in pollution management from the perspective of ecosystem self-organization. Such a model is a necessary pre-requisite to evaluate and utilize ecosystem's benefits to urban sustainable development in the process urbanization, and provide guidance for policy decision making to maximize the benefits.

Keywords: Ecosystem service, Pollutants reduction and management, Human health, Ecological loss, Emergy

Developing a fuzzy supplier selection model based on process quality from the viewpoint of sustainability

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Abstract:

Facing the current industrial environment of globalized competition, business sectors have been unable to solely rely on themselves to ensure their survival and growth or to maintain their long-term competitive advantages. Also, the issues related to global warming and climate change have been involved. Therefore, the supply chain management model integrating upstream and downstream manufacturers to form strategic partnership has become more and more popular in hopes of quickly responding to consumers' demands to strengthen business sectors' competitiveness. Besides, the environmental protection should be taken into consideration as well in order to keep the balance between economic development and environmental protection to reach the goal of sustainable development. At present, the output value of Taiwanese foundry amounts to 70% market share and the output value of IC packaging and testing also reaches 50% market share, which rank first in the world. Taiwanese electronic industry in the supply chain system of information and communication technology has a complete industrial eco-chain and plays a stable and crucial role in the electronic industry worldwide. In the entire industrial chain of labor division, it is necessary to select suppliers to ensure each part's quality as well as the final product's quality. In addition, quality enhancement can reduce the percentage of process scrap and rework, increase the lifetime of the product, and reduce the maintenance rate of the product, so that we can decrease the investments of resources and lower the environmental pollution and damage as well as social loss. Apparently, quality is one of the key factors which can environmentally sustain production. To sum up, this paper will construct a complete and sustainable green supplier selection model based on quality. First, six sigma indices which can completely reflect process yields as well as quality levels are selected as an assessment tool. Next, the confidence intervals of indices are used to derive Buckly's fuzzy numbers and the membership function, so that the fuzzy testing method which can reduce uncertain factors related to manufacturing process, measurement, and sampling errors is employed to evaluate and select suppliers. Meanwhile, forming strategic partnership with suppliers can also help business sectors improve their process quality in order to tally with the green concept of sustainable production.

Keywords: Supplier selection, Six sigma quality indices, Quality characteristics, Sustainable production

The optimization of waste water by its quality and quantity

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Abstract:

With the rapid development of China's economy and the increasing process of urbanization or industrialization, environmental pollution is becoming more and more serious. Environmental protection is now more and more important. Each kinds of water discharge standards request more stricter. So many industrial enterprises or sewage treatment facilities need to be upgraded, and the cost of sewage treatment is increasing greatly. Based on the water quality and quantity of each sewage treatment process outlet, and the water demand of various users, we can optimize the using of the reclaimed water. This article will analyse the feasibility and economy of this kind of optimization, find a way that while achieve the standards request for each type of water, reduce the energy consumption and operation cost during the process of wastewater treatment.

Keywords: Reclaimed water, Water-quality, Water-quantity, Optimization

An investigation into the applicability of building types for implementing circular economy principles

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Abstract:

The circular economy concept is growing in its prominence, with examples of its implementation emerging in various sectors. There are a number of drivers for adoption including the reduction of primary material usage and waste arising with associated cost savings, improved reliability in the sourcing of materials, reduced risk and increased competitiveness through new market offers. Worldwide there is noticeable upward trend in the development of circular economy policy and legislation, nationally and locally. Whilst the building sector in the UK is successful in diverting waste from landfill, through high recycling rates, much of this waste is down-cycled to a lower value and few materials are within closed loop recycling systems. Moreover, the amount of products that are re-used for the same original purpose is negligible when compared to the overall material usage by the sector. Consequently, the building sector has a long way to go to become truly circular. Research has shown that the challenges to the uptake of circular economy in construction are varied including the fragmented structure of the sector, an unclear business model and financial case, a lack of incentives to adopt circular economy practices and limited awareness. There are many opportunities to apply circular economy thinking across each stage of a building's lifecycle including designing for adaptability and deconstruction, using reclaimed and high-recycled content materials, utilising secondary materials and the leasing of products.

An area that has received little attention is how the implementation of the circular economy, may be affected by the type of building and its general context. As such, the aim of this paper is to assess the potential application of circular economy principles to different building types by analysing data from semi-structured interviews that have been undertaken with representatives across the UK construction supply chain. Key variables such as the client type, longevity of the building, design requirements, the ability to modularise and scalability have been identified. These variables have been mapped onto each building type to establish the constraints and opportunities, resulting in a list of recommendations. The results indicate that office buildings have the greatest potential, particularly the fit-out stage, followed by educational, retail and industrial buildings. Underlying factors for retail and office buildings include the opportunity to embed end of life thinking due to the high level of turnover of space and the type of client, who would wish to maximise revenue opportunities. For educational buildings, the requirements for flexible and modular buildings as well as clients with a long-term view were considered significant; for industrial buildings the simplicity in their design was viewed as important.

Keywords: Circular economy, Construction, Building type, Constraints, Opportunities

Novel carbon-based cathode bioelectrochemical systems for simultaneous wastewater treatment and energy recovery

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Abstract:

Bioelectrochemical systems (BES) are being explored as an innovative technology for wastewater treatment and energy recovery, which can convert chemical energy in wastewater organics directly into electricity. Performance and cost of cathodes hold the key to bioelectrochemical system development and future applications. Besides, the mechanism of oxygen reduction reaction (ORR) at neutral pH needs to be further studied. In this project, carbon based air-cathodes have been developed via novel carbon-based materials development, traditional carbon-based materials selection and modification, and air-cathode fabrication procedure optimization, in order to improve the performance of catalysis, reduce the cost of cathode and analyze the mechanism of cathode reaction. Furthermore, the synergy effect and mechanism of COD removal and power production in BES has been systematically studied. The main findings are as follows: (1) In terms of novel carbon-based materials, a nitrogen doped ionothermal carbon aerogel (NDC) synthesized from an ionic liquid has been proposed to improve the electricity production (2300±140 mW/m^2) through a four-electron pathway, and oxidized graphene that synthesized by hydrothermal method revealed a well improved H_2O_2 production. In the meantime, the influence of the N and O functional groups on the oxygen reduction reactions has also been studied, which could provide a theoretical basis for further preparations of ORR catalysts. (2) In terms of traditional carbon-based materials, the optimum composite activated carbon based cathode with a significant low cost revealed a 41% higher power production than Pt/C cathode through modifications of heat treatment and carbon black addition. Moreover, a novel conductive gas diffusion layer fabrication method has been proposed based PTFE and carbon black, which had a high oxygen mass transfer coefficient, high water pressure tolerance, and high power generation. Based on this conductive gas diffusion layer, a binder-free nitrogen-doped graphene catalyst air-cathode has been proposed by chemical vapor deposition (CVD). The internal resistance of this cathode decreased by 80% compared with Pt/C cathode, while the electricity generation performance was increased by 32%. (3) As for wastewater treatment performance, COD removal characteristics and current generation in BES have been systematically studied. It was found that COD removal and current generation had a synergy effect in BES, and high COD removal rate and high current production could be simultaneously achieved by regulating the external circuit. Overall, it is demonstrated that efficient wastewater treatment and energy recovery could be simultaneously achieved by using novel carbon-based cathode bioelectrochemical systems.

Keywords: Wastewater treatment, Energy recovery, Bioelectrochemical system,

Microbial fuel cell, Carbon-based cathode

Emission of carbon monoxide during composting of cow manure with grass and sawdust in laboratory conditions

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Abstract:

Carbon monoxide is a toxic gas emitted from many natural and anthropogenic sources, known primarily as a product of incomplete combustion. Emissions of carbon monoxide have been observed during the biological degradation of organic matter. However, also other gases are commonly being produced, such as N-compounds, volatile organic compounds, and others, among them the undesired carbon monoxide (CO) and hydrogen sulfide (H_2S). CO emission was observed during the composting of various materials including: green waste, green waste with manure, organic waste and municipal solid waste. The mechanism of CO emission from the degradation of organic matter has not been fully understood.

The aim of the study was to determine the emission of carbon monoxide (CO) during the composting process, depending on the temperature and activity of microorganisms (use of sterilized and non-sterilized waste).

The experiment was carried out on a material with a homogeneous composition, i.e.: green waste, manure, sawdust in a mass ratio of 1:1:1. The material with optimal humidity (60%) was subjected to a composting process, and placed in 1 dm^3 glass vessels having connectors for gas sampling. The composting of sterilized, and non-sterilized samples was carried out in a climatic chamber for 1 week at 10, 25, 30, 37, 40, 50, 60, 70°C.

The observed accumulated CO emission from the sterilized material was varying from 7.23 µg CO·g $d.m.^{-1}$ (10°C) to 136.85 µg CO·g $d.m.^{-1}$ (70°C). However, from non-sterile material from 16.47 µg CO·g $d.m.^{-1}$ (10°C) to 122.49 µg CO·g $d.m.^{-1}$ (70°C). In both variants, the emission of CO increased with the temperature. In the temperature range from 10 to 50°C higher emissions were observed from non-sterilized waste than sterilized. Oppositely, in case of temperatures above 50°C, higher emission was observed from sterilized material.

Keywords: Carbon monoxide, Emission, Composting, Greenhouse gases

Spatio-temporal dynamics of urbanization and energy consumption in China

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Abstract:

As urbanization accelerates, urban areas play an important role in energy consumption. Thus, a better understanding of the relationship between urbanization and energy consumption is necessary for economic and social development in the future. Based on the LMDI method and spatial autocorrelation analysis, this paper analyzed the spatio-temporal dynamics of urbanization and energy consumption at national and regional levels over the period of 1949-2015 in China. which can provide empirical evidences to better understand the connections among energy consumption, population growth, urbanization process, economic growth and technology development. We found that urban population, urbanization and economic development have positive effects on energy consumption at both national and regional level, while energy efficiency has negative effects. Besides, energy consumption is more influenced by economic development and energy efficiency than by population and urbanization. Furthermore, the effects of urbanization on energy consumption vary across regions. In addition, the influence of urban population and energy efficiency is clustered spatially, while urbanization and economic development are randomly distributed. Therefore, together with enhancing energy efficiency, a diversified urbanization strategy for different regions is suggested to realize sustainable and low carbon urbanization.

Keywords: Energy consumption, LMDI, Spatial autocorrelation, Urbanization

Evaluation of mechanical and durability properties of asphalt mixes comprising recycled materials as fillers

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Abstract:

One of the primary concerns amongst researchers is erroneous increase in waste generation from various industries. In order to limit degrading environmental impacts as well as to conserve natural resources, the recycling of waste materials in asphalt pavements would be extremely effective. This study performs preliminary characterization of seven widely occurring waste materials and their effects on the mechanical and durability properties of Dense graded bituminous macadam (DBM) mixtures when added as filler. Waste materials namely, waste glass powder (WGP), waste dimensional limestone dust (WLD), red mud (RM), rice straw ash (RSA), waste brick dust (WBD), carbide lime (CL), copper slag powder (CSP) along with ordinary Portland cement (OPC) were utilized as filler.

Physical characterization of waste materials was done using specific gravity, particle size distribution and German filler tests. Quantity and quality of clay were assessed using plasticity index and methylene blue value tests. Morphological and mineralogical analyses were done using Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD) techniques. Also, affinity of materials towards bitumen was assessed using pH value and hydrophilic coefficient tests. Optimum Binder Content (OBC) of control mixes prepared with OPC was determined as per Marshall mix design methods. At OBC, mixes with waste fillers were also fabricated and their strength and volumetric properties were determined. Rutting resistance and cracking resistance of various mixes were assessed using Marshall Quotient (MQ) and indirect tensile strength tests respectively. Resistance of mixes against moisture was estimated using retained Marshall stability (RMS), active and passive adhesion test values.

At same bitumen content, all mixes displayed satisfactory Marshall and volumetric properties required as per Indian paving specification. Mixes prepared with RSA, RM and CL showed relatively higher air void content which is attributed to higher porosity of these wastes. Higher air voids led to higher OBC in mixes which in turn increase bitumen consumption as well as cost of mix. No significant differences in the performance of waste mixes and control OPC mix in terms of rutting and cracking resistance were found. In case of moisture sensitivity, all mixes delivered satisfactory retained strengths and adhesion values. However, materials having higher porosity and predominance of silica in composition has relatively lower resistance against moisture. Calcium rich wastes namely, CL and WLD delivered superior resistance against moisture sensitivity due to their greater affinity with bitumen. Hence it can be

said that all studied waste materials can be utilized as alternative filler in DBM mixes.

Keywords: Filler, DBM mix, Waste materials, Marshall properties, Moisture resistance, Sustainability

Raw material requirements and availability for lithium-ion batteries under different technological developments

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Abstract:

As the cost of lithium-ion batteries continues to decline, their use increases rapidly for several different applications. This has also spurred an interest in the availability of raw materials that are used in the manufacturing of lithium-ion batteries, such as lithium, cobalt, nickel, manganese, and graphite. Several different battery chemistries exist, with slightly different properties, utilizing somewhat different materials. These technologies are still improving and the actual requirements of future storage capacity remain uncertain. Depending on the total growth in the use of Li-ion batteries, and the intensity of different raw materials used for to manufacture this storage capacity, the required material flows vary dramatically. By quantifying potential future requirements of some of the most important raw materials under potential developments of different Li-ion technologies for EV and stationary applications, the possibility of availability issues of these resources are analysed, taking into account the potential life expectancy for different applications. It is clear that depending on which battery chemistries that are used, in part depending on which battery properties are considered the most important for different applications, the required flows of many different materials vary greatly. Degradation of batteries under different uses and when a battery is considered to reach its end of life (EOL) also impacts the required material flows and the potential to get materials from EOL recycling. The potential availability of these materials both from primary and secondary resources must be evaluated dynamically over time and the potential of growth of all the industries in the supply chain must be considered. Taking into account the materials used at an early stage in the expanding lithium-ion battery industry could ensure that issues with material availability are avoided and that continued decreases in battery cost can be achieved.

Keywords: Resource availability, Lithium-ion batteries, Material flows

A novel framework to consequential life-cycle assessment to evaluate the effect of paper recovery and recycling

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Abstract:

Recycling has been one of key strategies to reduce the environmental burden associated with resource use. The lower energy requirement to produce recycled material products than ones made of virgin sources has motivated local or government policy makers to promote legislation that mandates the use of products made from recycled content. Many of these efforts are based on the results from the existing studies which can be categorized primarily as attributional life-cycle assessment (aLCA). Although these studies provide all physical flows that attribute to the product of interest or the current system, they may not evaluate potential changes in the environmental performance in response to a particular policy. Understanding the impact of policies or regulations around material recycling requires a system-wide perspective that quantifies potential indirect effects. Furthermore, decision-support tools with a consequential approach may help mitigate unintended consequences of such legislation.

This study presents a novel framework for consequential life-cycle assessment (cLCA) for the pulp and paper industry, which currently consumes 20% of global industrial energy consumption. In this work, we demonstrate how recycling policy that targets a specific paper product influences the environmental performance of industry overall. This study differs from existing cLCA studies, which are based on economic partial equilibrium models, in two aspects. First, this study explicitly considers the potential for material substitution (within varying grades of recovered paper) based on the current technical capabilities of the industry. Second, the influence of economic drivers for sourcing fibers on decisions between alternative substitution options are explored through scenario analyses. Results indicate that an environment policy that mandates the use of recycled content in particular products may not always improve the environmental performance of the pulp and paper industry due to the indirect effects in non-targeted products. The magnitude and directionality of environmental performance of this industry depends on the economic and technological conditions of the system that influence decisions for a choice of material substitution. The presentation will include analysis of system-wide behaviors of the pulp and paper industry in terms of material consumption, direct energy consumption and greenhouse gas emission changes and compare the results of different scenario analyses.

Keywords: Consequential life-cycle assessment, Paper recovery and recycling, Material substitution, System-wide performance

The Refuse Derived Fuel RDF torrefaction process energy consumption modeling based on the calorimetric analysis of its components

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Abstract:

Increasing requirements regarding the fuel properties of the produced Refuse Derived Fuel (RDF) from mixed municipal waste caused that research work on increasing the calorific value has begun. One of the proposed methods is torrefaction, a thermo-chemical process carried out in the temperature range from 200 to 300°C, in the absence of oxygen, at atmospheric pressure. The main product of this process is a solid material with increased carbon content. The results of our previous studies showed that this method allows to increase the RDF calorific value from 19 to 26 $MJ \cdot kg^{-1}$. The next step in the development of RDF torrefaction technology is to determine the energy demand.

This study presents the results of modeling process that describes the production of Carbonized Refuse Derived Fuel (CRDF) from individual materials included in mixed municipal waste, which would allow to minimize the energy demand for the torrefaction process. For this purpose, the results of the calorimetric analysis of the following waste morphological groups were used: paper, textiles, plastics, hygienic and biodegradable waste. Executed differential scanning calorimetry (DSC) analysis allowed to determine the energy demand/release of transformations occurring during heating from 15 to 350°C. The results showed that during transformation of biodegradable waste exothermal transformations were dominating (367.78 $J \cdot g^{-1}$), while in the case of plastic transformation, mainly endoenergetic transformations (-220.13 $J \cdot g^{-1}$) had been found. Additionally, based on the DSC analysis, the specific heat values of the tested materials were determined. For biodegradable materials, this value ranged from 71.27 to 80.37 $J \cdot (g \cdot K)^{-1}$, and plastics 7.12 to 16.49 $J \cdot (g \cdot K)^{-1}$ in the temperature range from 15 to 350°C.

Based on the results of the DSC analysis, a mathematical model was developed for calculation of energy balance depending on the percentage composition of the RDF and the set process temperature.

Keywords: Refuse derived fuel, Torrefaction, Mathematical model, Energy balance, Differential scanning calorymetry

A study of Chinese restaurant reverse logistics: Issues and challenges of kitchen waste disposal

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Abstract:

Purpose:

Nowadays, many organisations produce waste and contamination that are threatening the planet. The media and non-governmental organizations are starting more frequent global inquiries about the sustainability aspect of organisations' development (Sarkis, 2001). With the fast development of economy and improvement of people's living standards, China is facing an increasing amount of kitchen waste and the imposed critical pressure on city environment and sustainable development. For instance, the daily kitchen waste output of Chengdu has been exceeding 1000 tons since 2013, which occupies a large portion of the municipal waste (Zhong, 2013). If this kind of waste cannot be disposed of properly, they may pose a threat to a city's environment and residents' health.

The purpose of this study is to find out the recycling approaches that most Chengdu's restaurants are applying, analyse the potential problems behind, and propose possible improvement practices. Three research questions are going to be answered: (1) What are the main recycling and reprocessing methods in Chengdu? (2) Why to apply improper kitchen waste disposal methods? (3) How to improve Chengdu's kitchen waste disposal network?

Methodology:

To achieve research targets and provide answers to research questions, a survey study was carried out. The participants of the survey study are practitioners and academics who have a clear and deep understanding of the waste disposal in Chengdu. 243 valid replies were collected in August 2017 and the correlation analysis was then conducted.

Findings:

Many Chengdu's restaurants are still selling kitchen waste to local farmers without refining. The main reason for still using insanitary disposal method is that many restaurants want to sell those wastes quickly so as to make more profits. To solve these problems, the government and the industry should endorse the legislation and tighten up enforcement to improve the kitchen waste handling from source. They should also promote preferential policies such as using taxation lever to adjust stakeholders' interests. Furthermore, the improvement of technology can also help to

solve improper waste disposal issues.

Value and Implication:

This study investigates the reverse logistics network of Chengdu, which strengthens the understanding of both academics and practitioners in the field of waste disposal, sustainable development, and the food industry. By analysing and discussing the process of kitchen waste disposal and recycling in Chengdu, academics could extend their knowledge of reverse logistics practices in China. The practitioners could recognise the possible improvement direction to enhance the current waste disposal mode.

Limitation:

This study only focuses on Chengdu, which is a large and an important city in China. Due to the contextual economic and cultural environment, more cities should be involved in the future study to better capture the kitchen waste disposal in China.

Acknowledgment:

We would like to thank Jingwei Shi for the help of data collection.

Reference:

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Keywords: Reverse logistics, Sustainable development, Kitchen waste disposal, China

A multi-objective optimization approach for economically and environmentally conscious development of shale gas produced water desalination strategies

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Abstract:

A critical challenge associated with the rapidly developing shale gas industry in the U.S. is the management of high salinity produced water. Desalination technologies are energy intensive, and high salinity of produced water results in even higher energy requirements with implications for economic and environmental impacts. Produced water desalination schemes consist of three major steps which determine the specific energy consumption of the process, required investment and operating cost, and associated environmental impacts. These steps include desalination technology selection, energy sourcing, and brine management. Different desalination technologies could be potentially applied to treat the produced water with varying energy consumption and different operational restrictions. Depending on the selected technology, energy requirements could be provided by conventional fuels, electricity, and waste heat. Desalination concentrated brine could be managed by directly transporting and injecting the brine into deep wells, or by processing the brine through crystallizers to achieve zero-liquid discharge and disposal of the produced solids into landfills. Various combinations of desalination technology, brine management option, and energy sources will result in different capital investment, energy consumption, and environmental impacts. There is a need to systematically analyze the economic and environmental impacts associated with management of produced water from the shale gas industry and address associated challenges and limitations. However, such an analysis is missing in the field of produced water management.

We present a multi-objective optimization framework for investigating economically and environmentally conscious management schemes for produced water desalination and brine stream management. Mechanical vapor recompression (MVR) and direct contact membrane distillation (DCMD) are specifically analyzed and compared as two desalination technologies capable of handling high saline produced water under competitive condition regarding their energy quality requirement, energy efficiency, and their capital cost. The analysis is conducted for different ranges of input variables such as feed salinity, production capacity, and plant lifetime to identify optimum combinations. The analysis is carried on through thermo-economics comparison of MVR and DCMD systems, thermo-economics comparison of brine management options, carbon footprint comparison of desalination systems and brine

management options, energy sources, capital investment, and operational restrictions consideration of each combination of desalination and brine management. The results of the multi-objective optimization framework will be compared with single objective optimization and the implications of the findings for sustainable management of produced water will be discussed.

Keywords: Produced water desalination, Optimization, Environmental impacts, Mechanical vapor recompression, Membrane distillation

Reasons behind the abandonment of Environmental Management Systems certification: A survey analysis

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Abstract:

Together with the international standard ISO 14001, the Eco-Management and Audit Scheme (EMAS) is the more diffused Environmental Management System in the European Union. Italy accounts for over 1,000 EMAS organizations, representing about a quarter of all European Registrations. Over the last years, the registered organizations have not grown, showing instead the emergence of a decertification trend. In Italy, the EMAS decertification phenomenon was particularly evident. The aim of the research presented is to investigate the reasons behind this negative trend.

The research was carried out with a two-step approach. First semi-structured interviews were conducted with several EMAS registered organizations. Next, results were used to build a questionnaire targeted to all Italian organizations that did not renew the registration between 2010 and June 2015. From an initial population of 379 organizations, respondents were 99. In the questionnaire, organizations were asked to identify motivations for dropping out of EMAS and potential measures to be implemented by competent public authorities to stimulate organizations to move back to the certification. First, data were analyzed through a Principal Component Analysis (PCA) to identify the dimensions able to summarize the reasons to abandon EMAS. From an initial set of 43 variables, 8 components were identified. These components describe motivations for not renewing EMAS that mainly relates to saving in processes environmental efficiency, regulatory relief and incentives, internal managerial difficulties, EMAS visibility in the market, costs, relationships with public authorities, and strategic factors. Next, these latent variables were employed to classify data in three clusters through the K-Means method. Clusters were then analyzed with descriptive statistics, considering organizations main demographic characteristics. Additionally, each of them was analyzed in relation to a list of measures to be implemented by competent public authorities able to potentially stimulate organizations to return to the certification. Respondents identified as most suitable enabling measures: the increase of regulatory relief; the implementation of financial incentives; an enhanced importance of EMAS in obtaining public funding; the increase of tax benefits in the long-term; an enhanced importance of EMAS in the public funding mechanisms compared to ISO 14001. Thus, results show that organizations would be willing to move back to EMAS if the public authorities would give them more financial and market incentives. Findings will support EMAS competent bodies, both at national and European level, providing a baseline to re-

launch the Scheme which has been recognized as pivotal in supporting the transition toward circular economy.

Keywords: Environmental management systems, Certification abandonment, EMAS, Principal component analysis

How environmental practices and communication influence guest loyalty? A survey study about the European Ecolabel in Italian hotels

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Abstract:

Since consumers' concern toward environmental sustainability is rapidly growing, businesses are providing environmentally responsible products and services. The hospitality industry is developing voluntary-based tools in order to reduce its environmental impacts and to satisfy the increasing market segment of green customers. Therefore, the commitment toward sustainability may represent for hoteliers a strategy to increase competitiveness and, simultaneously, mitigate their impact on the natural environment. In this context, third-party certified ecolabels ensure hotel compliance with specific environmental performance criteria and offer a reliable communication to their guests. The study investigates whether environmental practices implemented by EU-Ecolabel certified hotels contribute significantly to the formation of guest positive behavioral intention toward green hotels. During 2017, a survey was conducted with guests of three Italian hotels awarded with EU-Ecolabel, followed by semi structured interviews to hotel managers. The questionnaire's items were selected after examining the existing literature, while the semi structured interview was administered to follow-up on the analysis of the questionnaire results. Over 300 questionnaires were usable and employed in the analysis. We chose PLS-SEM modeling to estimate the structural equation models and to test the hypothesis, and the SmartPLS software to build models and assess their validity. Research findings are valuable both for hotel managers and decision makers. To hotel managers by clarifying the role of environmental communication in the guests' recognition of environmental performance improvement efforts; and to decision makers by confirming the relationship between the implementation of environmental practices and the raise of market awareness and thus, their loyalty towards green hotels. Results of the study also confirm that the perceived importance of sustainability in tourism influences guest loyalty towards green hotels and their evaluation of environmental communication. By reinforcing the importance of an effective environmental communication to clearly disclose hotels' achievements toward sustainability, this ability is considered essential to capture the potential competitive advantage of an environmental strategy.

Keywords: Ecolabels, Tourism sector, Hotel, Italy, Environmental practices, Environmental communication, Customer loyalty

Laboratory study of recycled phosphogypsum, tropical soil and cement mixtures in wet and dry environmental conditions

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Abstract:

The phosphogypsum (PG) is a byproduct from phosphoric acid production, is usually disposed in outdoor storage and can cause environmental impacts. One way to reuse the PG is in asphalt pavement layers. Some international studies indicate the use of chemical stabilizer to reduce the soluble agents' contamination of PG mixtures. Others research publications show that the hemi-hydrate (HH) phosphogypsum, also called bassanite, presents better mechanical behavior than the di-hydrated (DH). In Brazil Middle-West the PG produced is the DH. Therefore, in this paper the DH was transformed into HH in laboratory using a thermal treatment process. Other important point for pavements materials is their evaluation when submitted to critical situation as wet condition. As the PG is sensitive for water content variation, this paper aims to: i) investigate the HH use mixed with a lateritic soil commonly found in the region and cement considering the mechanical and durability characteristics in wet and dry cycles, ii) verify the environmental aspect by the soluble agents' contamination evaluation. The soil was classified as A-4 (TRB system) and ML (USCS system) and mixed with different contents of HH and cement based in previous studies: Sample 1 (80%soil + 11%HH + 9%cement), Sample 2 (50%soil + 41%HH + 9%cement) and Sample 3 (50%soil + 50%HH). All materials were characterized by laboratory tests as grain size distribution, plasticity index, specific gravity, tests for tropical soil and chemical stabilization (disk method and methylene blue test), according to current Brazilian standards. Compaction curves in the Brazilian intermediary Proctor energy for each sample were defined in a fixed time after the moistening (from 5 to 25 minutes). In the durability tests, the samples were cured for 7 days in a wet chamber and after, 12 cycles of wetting, brushing and drying were applied according to ASTM International. Unconfined compression tests were done after 7 curing days and after durability tests with 1, 6 and 12 cycles. The resilient moduli (MR) were found by dynamic triaxial tests for different curing times (0, 7 and 28 days) as well different curing types (wet and dry). Scanning Electron Microscopy (SEM) images were obtained to analyses the samples' microstructural and to understand the changes in the behavior considering the effects of the cement addition and the water presence. The results have shown that the durability is satisfactory for all the samples, but it is better for Sample 2. This fact indicates that the use of HH higher values and cement has a potential use. The wet curing cause

increase in the water content and reduction in the MR values, but all samples presented good MR results and can be used in subbase and base layers. Based on the results it is possible to conclude that the recycled phosphogypsum, tropical soil and cement mixtures present technical viability for pavements construction. The solubility tests are being performed and will show if the cement can contribute as a HH mixtures solidifying, avoiding the water contamination and ensuring the environmental application of this byproduct.

Keywords: Bassanite, Road base, Chemical stabilization, Laboratory tests

The oxygen transfer capacity of submerged plant Elodea densa in wastewater constructed wetlands

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Abstract:

There are insufficient data for the development of process design criteria for constructed wetland (CW) systems based on submerged plants as a major treatment agent. The submerged plants may be suited for final effluent polishing after CW or other wastewater treatment units. The aim of the study was to evaluate the oxygen transfer capacity (OTC) of Elodea densa, in relation to fresh plants' biomass (f.b.). Additionally, the influence of Elodea densa on the oxygen concentration and contaminants removal efficiency from municipal wastewater was tested.

The obtained oxygen concentration and temperature data allowed to calculate the OTC values [$mgO_2.L^{-1}.h^{-1}$], which had been related to fresh plants biomass unit [$mgO_2.L^{-1}.h^{-1}.g$ f.b.$^{-1}$]. The efficiency of wastewater treatment by Elodea densa was determined in relation to initial wastewater content in mixture of wastewater and tap water (0 %; 25 %; 50 % and 100 %), during 3 days of hydraulic retention time. The simulation of day (12 h) and night conditions (12 h) was done by artificial lightening. In both experiments the light intensity was 100 [$W.m^{-2}$]. Before starting and after finishing the second experiment, the COD, Ntotal and P-PO_4 concentration were analyzed in wastewater solutions.

The significant linear correlation between fresh plants biomass of Elodea densa and the OTC has been determined. The OTC ranged from 3.19 to 8.34 [$mgO_2.L^{-1}.h^{-1}.g$ f.b.$^{-1}$].

The Elodea densa influenced on oxygen concentration in wastewater solutions by photosynthesis and respiration activity. The research showed that Elodea densa affected positively on the wastewater treatment efficiency, and the highest efficiency was achieved in 25 % wastewater solution: 43.6 % for COD, 52.9 % for Ntotal, and 14.9 % for P-PO_4.

Keywords: Constructed wetlands, Wastewater, Submerged plants, Oxygen transfer capacity

Characteristic and flow analysis on specified waste from domestic manufacturing industry in South Korea

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Abstract:

Currently specified waste management in South Korea can be divided into the generation, collection, transportation and treatment according to the current law. In consideration of the sources, constituents and harmfulness of specified wastes, 11 kinds of specified wastes, 35 kinds of middle classifications, and the type and the classification number of each type are controlled and managed. In order to track and manage the proper treatment of waste, we have been implementing the 'Waste Treatment Proof System' since 1999. Since 2002, we have been using the computerized information processing system (Allbaro system) for efficiency improvement and transparent waste. In addition, the Korea Environment Corporation collects the statistical data of the specified waste through the system correctly, and announces the statistics as 'Specified waste generation and disposal status' every year.

According to the 'Specified waste generation and disposal status'', the amount of designated waste generated in 2015 is 4,691,532 tons, which is 51.7% higher than the amount of 3,092,591 tons generated in 2005, and the annual output is steadily increasing at 3.25%. Therefore, in order to properly manage the specified wastes, it is necessary to divide the wastes according to the type of industry and waste type, and to evaluate the trend of specified waste generation in advance and establish a specified waste management plan. However, due to the collection of statistical data and administrative procedures, the timing of publication of national statistical data is somewhat delayed from the actual generation of specified waste.

In this study, we investigated the generation and treatment of specified waste generated in domestic manufacturing industry. In 2005 and 2015, waste flow analysis was conducted and the purpose of this study is to analyze the change of the generation and disposal process of specified wastes during the last 10 years, to identify the main sources and sources of specified wastes in the domestic manufacturing industry and to provide basic data for establishing the specified waste management policy in the future.

In addition, we analyzed the correlation between the production index, which is an economic index indicating the change in the output of the products produced by the industry, and the specified waste generation amount. Based on the actual production index, the specified waste statistics for 2017 are predicted and compared with the

estimated amount and the actual amount for the period from 2010 to 2015.

Using the results of this study, it is expected that the amount of specified waste to be generated will be predicted without any additional analysis in the currently operated specified waste treatment facility. In addition, dust, waste acid and other organic solvents generated in the primary metal manufacturing, electronic components, computer, video, sound and communication equipment manufacturing, chemical and chemical manufacturing industries are expected to increase from 44.7% in 2015 to 51.6% %, and the polarized production of specified wastes by industry is expected to worsen. When establishing the waste management policy, it is necessary to manage the major industries.

Keywords: Waste flow analysis, Domestic waste, Waste generation, Waste treatment, Index

Household waste flow analysis and management evaluation index in South Korea

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Abstract:

The development of advanced science and technology has greatly contributed to the development of human civilization and solved problems such as food insufficiency and diseases. On the other hand, problems of increased waste accompanying rapid population increase and industrial development are emerging. Up to date, therefore, many studies have been conducted related with waste management, treatment, reuse and recycling.

Since the 1990s, Korean government policy on waste has focused on reducing landfill and resource recycling society that enhances recycling. Korean government has established a variety of policies such as the “Basic Resource Recycling Plan”. This also applies to the “Basic Resource Recycling Law” planned to be implemented from 2018 onwards. As a result of enforcement of these various policies, the landfill disposal rate has been continuously decreasing in the case of waste at the site after 2008, and the recycling shows an increasing trend.

In this study, we conducted a waste flow analysis in household waste system in South Korea. The waste flow analysis can show a quantitatively view the overall household flow. In addition, starting with 2007, which is a planned year to enhance the strengthening of the institutional and physical infrastructure for the construction of a sustainable urban environmental management system, it was selected based on the total of three years in 2012 and 2015. We also developed a waste management evaluation index that can tell the trend of all 16 local government waste disposal methods.

As a result, the waste flow analysis and mapping of household waste generated were conducted and compared in 2007, 2012 and 2015. In the case of the waste management evaluation index, it is the final evaluation index that combines an index for determining the rate of change in waste disposal method and an index with weight on current recycling landfill.

Keywords: Household waste flow analysis, Waste management, Waste management evaluation index

The impact of digitalisation on resource efficiency in the steel industry

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Abstract:

The steel industry accounts for about 6.5 % of the global anthropogenic carbon dioxide emissions (World Steel Association 2012). Hence, it is essential to use energy and resources in this industry efficiently to reduce global carbon dioxide emissions.

Digitalization or “industry 4.0” is about to substantially change the industry sector in the next years. Digitalization is likely to affect production processes strongly; digitalization might lead to fundamental changes in the use of labor; and digitalization might turn upside down the structure of entire companies. Visions for factories of the future include concepts such as “one site - one tablet - one worker”, “zero-waste-production” and “complete recycling”. Studies on the current state and future implications of digitalization in the steel industry are scarce.

This contribution analyses developments in the digitalization of the European steel industry. We review research and developments projects of the key funding program for the European steel industry (i.e. Research Fund for Coal and Steel) from 2003 to 2016 and identify projects in the field of digitalization and industry 4.0. We review abstracts, titles, research partners and to some extend project reports or other available data based on a previously set definition of digitalization. We then systematically analyze and structure these activities. We establish an activity map of actors (e.g. companies, research institutions) and show to which processes digitalization is applied (e.g. blast furnace, rolling, finishing). We highlight key projects e.g. on digitalization and circular economy. The contribution concludes with a qualitative impact assessment of digitalisation on resource efficiency in the steel industry.

Keywords: Resource management, Waste reduction, Sustainable supply chain, Circular economy, Digitalisation, Industry sector, Steel industry

Evaluating the Sustainability of Desalination Implementation and Management in the Bi-national Santa Teresa, NM Community

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Abstract:

Global realities of water shortages and population growth–coupled with water quality concerns – increase tension over water allocation and jeopardize the sustainment of societies. Desalination of brackish water exists as a potential solution to expand inland freshwater supplies. Burgeoning industry and population in the bi-national Santa Teresa, NM community place strain on its limited freshwater. The urgency of these resource constraints necessitates an examination of desalination, as its effects here remain unknown. Previous sustainability research analyzed social, environmental, and financial concerns in relative isolation. Nascent efforts in the hydrology field call for establishing integrative research methods. This approach has not been applied to a desalination or water management system revision case study. Our study creates a system dynamics model to account for interdependent environmental, social, and economic factors that comprise a socio-hydrologic system affecting the sustainability of inland desalination implementation and management for the region. Expected results from this research will inform emerging policy decision-making efforts in greater Santa Teresa regarding the future of the community's water management. This expansion of water supply restructuring literature related to desalination implementation from a sustainability perspective will additionally provide small communities facing similar water challenges with an integrative, system perspective case study.

Keywords: Water, Sustainability, Desalination, System dynamics, Water management

Impacts of iron and steel industry on air quality in "2+26" cities in China: Effect of policy control and future scenarios

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Abstract:

Nowadays, air pollution is still a serious challenge for China, especially the heavy haze in Beijing-Tianjin-Hebei (BTH) region and surrounding areas in fall and winter seasons. To reduce air pollution, Chinese government issued environmental targets for key industries, such as iron and steel industry. Large amounts of pollutants such as sulfur dioxide(SO_2), nitrogen oxides(NO_x), volatile organic compound(VOCs), and dioxin(PCDD/Fs) are emitted during steel manufacture process. Although tremendous efforts have been made to reduce emissions from steel industry by sources prevention, process control and end of treatment recently, the target is still strict on steel industry. In this study, the policy control scenario of decreasing steel production 50% during heating season and future development scenarios of iron and steel in medium and long terms in the "2+26" Cities in BTH are established. Then, impacts of the scenarios on air quality are simulated with the Community Multiscale Air Quality (CMAQ) model. The emissions from other sources will be generated based on the EDGAR inventory and changes of major air pollutants in a summer mouth and winter heating months in the scenarios will be quantified. This study is well suited as a base for decisions regarding the control of air pollution emission and environment management for iron and steel industry.

Keywords: Iron and steel, Emission, Air quality, CMAQ, China

A naturalistic decision making study on the effectiveness of ecolabels in inform sustainable consumption

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Abstract:

As the world population increases drastically (which will reach 9.4 billion by 2050), promoting sustainable consumption is critical in order to meet the increasing consumption needs. Individual purchasing decisions play a significant role in determining our collective environmental impacts. For products with long life span (e.g. cars and washers), once the products are purchased, the consumers are locked-in for the next five to ten years at the resources and energy efficiency of the product. For products with short life span is relatively short (e.g. groceries), different products not only have different embedded environmental impacts (from upstream production and transportation) but also generate different post-consumption wastes. Therefore, guiding consumers to select more environmentally friendly products is important to promote sustainable consumption. One important way to inform consumers about the environmental performance and sustainability information of a product is using environmental labels (Ecolabel), which are voluntary identifiers on product's package that represent environmental characteristics. During the past 20 to 30 years, many studies have been conducted to investigate consumers' attitude towards ecolabels or examining consumer's willingness-to-pay (WTP) for ecolabeled products, mainly using simulated shopping experiment or online surveys. However, results from simulated experiment may not reflect consumer's behavior in naturalistic environment (limited number of information clues, not using real money). And during online surveys, consumers may have difficulty to evaluate their actual use of the labels and over-report may occur.

Therefore, our study aims to fill this gap by examining the effectiveness of ecolabels in informing sustainable consumption in a naturalistic shopping environment. Consumer behavior data are collected using eye tracking glasses from 130 shoppers in a local supermarket. Post-shopping survey and interview are also conducted to collect demographical and attitudes information. The results show that: (1) USDA Organic and Non GMO are the two most frequently identified ecolabels on the purchased products; (2) ecolabeled products' purchasers are relatively older, more educated, and with higher income; (3) the majority of the participants (52%) do not evaluate product information at all for any of the items they purchased and in total only 8% of the purchased products are evaluated, indicating that most of the products are purchased through habitual shopping; (4) consumers rarely pay attentions to ecolabels even though products with ecolabels have been purchased; and (5) when evaluating a product, participants follow product appearance, nutrition information, price, and use-by date, but the attentions shift from price to product quality attributes for ecolabeled products.

Keywords: Ecolabel, Sustainable consumption, Eye tracking, Naturalistic shopping behavior, Visual attention

Environmental assessment of wastewater treatment systems involving constructed wetlands with and without forced aeration

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Abstract:

Wastewater treatment systems, while allowing the elimination or reduction of pollutants and unwanted substances in wastewater, also cause environmental impacts. Life Cycle Assessment (LCA) is one of the methodologies that can be used to evaluate the environmental performance of wastewater treatment systems. In the present study, the LCA was used to evaluate the potential impacts of a system compost by a constructed wetland with vertical subsurface flow followed by a constructed wetland with horizontal surface flow. And another system involving a free flow constructed wetland with forced aeration and a vertical subsurface flow constructed wetland. In the analyzes, the potential environmental impacts of the combined composting of the sludge and the vegetal biomass produced in the systems were also considered. The modeling of the systems and the calculations involved in the assessment of the life cycle impacts were performed using the software OpenLCA v. 1.6.3. The ReCiPe impact assessment method was used to assess the impact categories of terrestrial acidification, climate change, eutrophication, photochemical oxidation, human toxicity and freshwater ecotoxicity. It was found in all the analyzes that for the categories of eutrophication, climate change, and formation of photochemical oxidants, the operation stage was the one that most contributed to the potential environmental impacts.

Keywords: Life cycle assessment, Wastewater, Constructed wetlands, Aeration, Composting

Life-cycle analysis of source separated wastewater treatment and urine derived fertilizer production

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Abstract:

Substantial inputs of energy and nonrenewable materials are used to produce synthetic fertilizers, only to use additional energy and chemicals to remove these vital nutrients during wastewater treatment. Technologies are emerging that separate urine before it enters the wastewater stream and can process it to create fertilizer products, recycling previously unrecovered nutrients. The life cycle assessment is a comprehensive framework for comparing conventional wastewater treatment and fertilizer production systems with urine diversion systems. The urine derived fertilizer products include a concentrated urine that is stabilized to prevent hydrolysis, precipitated struvite, and ammonium sulfate produced from an ion exchange process. This study examines the impacts of urine separation, from reduced water consumption, different methods of wastewater conveyance, resulting changes in wastewater treatment from differing water quantity and quality, and the impacts of producing and distributing these fertilizers. The life cycle impacts will be assessed using the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). Preliminary results have indicated that reduced volume has decreased water consumption and the electricity needed to produce and treat water, and that the urine derived fertilizers require less energy and nonrenewable resources than conventional fertilizers. The full life cycle results will be presented, which will include cumulative energy demand, greenhouse gas emissions, acidification, eutrophication, and water use due to reduced nutrients in wastewater and impacts of conveying urine. This study characterizes the environmental impacts from multiple system level changes using a framework that can be applied in other locations.

Keywords: Source separation, Urine diversion, Struvite, Wastewater treatment, Resource recovery, LCA, Nitrogen, Phosphorus

Immobilization and utilization of hazardous jarosite waste by lime stabilization

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Abstract:

The speedy development of industrialization causes the shortage of valuable land. Along these, it is a fundamental need to impact the R&D societal orders to accomplish sustainable, monetary and social advantages from the gigantic usage of waste for widespread guides. The current study promotes the influence of lime content (L) in geotechnical properties of jarosite waste (solid waste residues produced from hydrometallurgy operations involved in the extraction of Zinc). As per toxicity characteristics leachate procedure (TCLP), the jarosite have heavy metals concentrations beyond the permissible limits, thus categorized as a hazardous waste. For immobilization of these heavy metals, the jarosite waste was stabilized/solidified by lime treatment. Numerous strengths tests (unconfined compression (qu) and splitting tensile strength (qt)) are conducted on jarosite-lime blends (Lime, 2.5-10% by dry weight of jarosite) with different curing periods (7, 28 & 90 days). The results indicate that both qu and qt increase with the increase in lime content along with curing periods. The stabilized jarosite-lime blend was checked for leachate and it was observed that the heavy metals in the stabilized product was immobilized and falls under the permissible limits. The increased strength with the addition of lime is also observed from the microstructural study, which illustrates the occurrence of larger agglomeration of jarosite-lime blend particles. The Freezing-Thawing (F-T) durability analysis is also conducted for all the jarosite-lime blends and found that the reduction in unconfined compressive strength after five successive F-T cycles improved from 62% (natural jarosite waste) to 46.50, 30.43, 28.47 and 24.63% with 2.5, 5.0, 7.5 and 10% of lime content, curing at 28 days period respectively. As per the guidelines of U.S. Army Corp of Engineers, the stabilized product may be used as a civil engineering construction material for subgrade and subbase design of flexible and rigid pavements. It can be perceived from this investigation that, mixing of cementing substances (lime) with jarosite waste resulting in a substantial change in geotechnical characteristics with economical as well as environmental concern.

Keywords: Jarosite waste, Lime stabilization, Strength study, Durability study, Leachate study, Microstructural study, Application

How is the 'achievements' for a megacity in China to promote the green buildings at a large scale?

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Abstract:

This paper is designed to employ life cycle assessment approach to characterize the environmental impacts (measured by carbon emissions, CO_2e) of public buildings in Shenzhen where is one of the first demonstration cities to promote the green development, including: (1) Develop a LCA framework to assess the impacts of the existing public buildings with consideration of many-years green transition efforts, and answer that how the achievement is so far. (2) Predict future carbon emission reduction potentials and determine the optimal reduction measures through appropriate scenario analysis. Specifically, estimate and projection of carbon emissions was calculated by using LCA, in terms of the building floor area, building materials consumption, energy use and corresponding emission factors, which were extracted from literature, field investigation and the database of China Southern Power Grid, respectively. The results show that: the total carbon emissions have increased rapidly from 16 Million metric ton (Mt) in 2005 to 29 Mt CO2e in 2015 due to the fast growth of the area of public buildings. However, current low-carbon efforts has only reduced 6 Mt CO_2e (cumulative value, from 2005 to 2015), and thus could not contribute proportionally to the city's overall carbon emission reduction target. In addition, we have modelled three development patterns of the public buildings subjected to more effective low-carbon policies, advanced construction technologies and green building materials. However, only the optimal measure that transforming the existed buildings into energy-saving buildings by the operating system optimization as soon as possible could significantly inhibit the rapid growth trends of carbon emissions and then meet the city reduction goal. These findings could not only inform evidence based policy making to facilitate the low-carbon transition of the public buildings in Shenzhen, but also shed light on sustainable urban transition in other megacities.

Keywords: Public buildings, Life cycle assessment (LCA), Carbon emission, Shenzhen

Dynamic stock-flow modeling for urban residential building in China: A homogenous-heterogeneous dichotomy perspective

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Abstract:

From the perspective of urban metabolism, one of the evident characteristics of rapid urbanization is the accumulation of buildings in urban areas. Such building stock accumulation would be accompanied by dynamics of construction materials flows (defined as homogenous flow relative to building stock) and function maintenance flows as water and energy (defined as heterogeneous flow relative to building stock). To test such hypothesis and to explore the dynamic behaviors of those homogenous and heterogeneous flows, a Stella based model was developed for modelling the residential building sector of Beijing in China, with regard to the construction material flows and function maintenance resource demands. Using this model, different policy scenarios have been investigated to explore the possible pathways to reduce resource and environmental pressures associated with rapid urbanization. The results show that the residential building stock presented a “S” shape pattern, with decoupled trend with homogenous flow but coupled trend with demand for water and energy. The peak value for total residential building stock in Beijing was predicted to reach 59 billion m^2 by 2027, and the demand for water and energy would be 66.8 billion m^3 and 8.13 trillion kw·h respectively at that time. Modelling results in this paper suggest that there would be a transition for city in the future from relying construction material inputs to maintenance demand inputs as water and energy. Scenario analysis further demonstrated that prolonging lifetime and optimizing design of buildings are effective ways to reduce resource demand from as well as environmental to its hinterlands.

Keywords: Urbanization, Residential building, Stella based model, China

Urban carbon leakage cross boundaries: Analysis of full supply chains

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Abstract:

Cities are increasingly linked to domestic and foreign markets during rapid globalization of trade. While trans-boundary carbon footprints of cities have been recently highlighted, we still have few understanding of how trade-related carbon leakage are reshaping urban carbon footprints through time and how economic sectors contribute to such leakage differently. In this study, we propose an integrated input-output approach to trace the dynamics of carbon linkages associated with urban sectors of different components of input. This approach quantifies full linkages in the urban carbon system from both production- and consumption-based perspectives. We assess the diverse influences of multi-scale linkages induced by local, domestic, and international inputs on role switching of economic sectors, and then the carbon leakage along with network linkages at both sector and process levels.

Using Beijing as a case study, we find that trade with domestic and foreign markets has an increasing impact on the city's carbon metabolism with more distant linkages during the period from 1990 to 2012. The socioeconomic changes in Beijing deliver some serious thinking on how the tracking of carbon emission can be improved for cities. We find a clear trend of temporal and spatial carbon leakage associated with the urban economy. On one hand, total carbon footprint of the city has been increased by 5 times from 1990 to 2012 as a result of rapid urbanization. We find that the carbon emission originated from outside city boundary increased to 57% in 2012, much higher than what it was in the 1990s. The Services and Construction sectors have been increasing their roles in carbon footprint by triggering denser carbon linkages compared to the average level of the urban economy. Growth in per capita consumption is one of the major reasons for the recent drastic increase in the carbon footprint. Due to limited capacity, the ever-increasing demand of the city can only be met by pushing environmental pressures (including carbon emission) outside the city gradually over time. The transplant of "network thinking" to input-output linkage analysis provides important details on when and where carbon leakage occurs in cities and how to tailor the regulation on urban sectors to their roles.

Keywords: Carbon footprints, Carbon leakage, Input-output analysis, Beijing

Dynamics of urban housing stock in Xiamen from 1985 to 2015

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Abstract:

The housing stock is not only an important component in urban infrastructure system, but also represents a key driver of materials consumption and environment changes. China's rapid urbanization leads to huge housing demands and consumptions in cities. Xiamen, as a representative city and a special economic zone, was selected as study area. The urban housing data in Xiamen were collected and analyzed by a dynamic material flow analysis model during 1985-2015. The data from geographical information systems (GIS) were helpful in the assessment of housing quantity and quality through assessing house's area, floor, age, and structure (related to material intensities). Finally, we evaluated the total quantity of material stocks in housing and quantified their spatial patterns. The results of our study should be useful for policies design and materials management in cities, and could be helpful for urban planning and sustainability.

Keywords: Housing stock, GIS, Xiamen

Assessing changes in residential electric power consumption due to emerging changes in climate and technology

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Abstract:

Residential use contributes to the largest electricity consumption in the U.S., but the future trend of residential electricity consumption is highly uncertain On one hand, climate change and the adoption of electric vehicles (EV) may increase the residential electricity demand from the grid. On the other hand, the development of photovoltaics (PV) and its drastically decreasing cost has a potential to increase residential adoption of solar PV panels, which will decrease electricity demand from the grid. The combined impact of climate changes and these emerging technologies remains unclear on residential electric power consumption. Understanding this demand change is critical for developing sustainable and resilient grid systems. In this work, we use agent-based modeling to assess the potential residential electricity demand changes regarding to different projected climate change scenarios and potential adoption of electric vehicles (EVs) and photovoltaics (PV). Using the Indiana-Ohio region as a case study, we use real world electricity consumption data as inputs for our model. Our model considers the impact of demographics, residential information, travel demands, social impacts, personal preference of technology acceptance, and cost sensitivity on EV and PV adoptions. Three climate change scenarios are modeled according to Intergovernmental Panel on Climate Change (IPCC) projections, having 0.79-3.6% increase in power demand compared to the 2016 level. Based on the climate change scenarios, our results show that (1) up to 40% and 45% households will adopt EV and PV by 2050, respectively, with PVs providing adopters with about 70% of the electricity demand; (2) EV and PV adoption can potentially change the residential electricity demand from the grid by -14% to +24%; and (3) government incentives and battery cost reduction can significantly impact EV adoption and increase electricity demand from the grid. Implications from this study help understand how the changes of climate and emerging technology may affect residential electricity consumption and inform policy decisions for grid related development and design.

Keywords: Electricity consumption, Electric vehicles, Photovoltaics

Shared autonomous vehicle systems: How many are needed and what are the sustainability implications

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Abstract:

A shared autonomous vehicle (SAV) system, in which autonomous vehicles are used as a car sharing system for on-demand service, has the potential to reduce the number of vehicles in need, but SAV may also increase the system's total mileage traveled, due to increased demand, extra shuttling mileages, etc. However, the tradeoffs between reduced vehicle number and increased vehicle mileages of a SAV system remains unclear. This work aims to fill this gap hereof. In this work, we build an optimization model to determine the optimal SAV fleet size to satisfy known travel demands, evaluate the increase of vehicle miles traveled (VMT), and calculate the net greenhouse gas emissions impacts of a SAV system.

Using the taxi fleet in Beijing, Chengdu, and New York City as case studies, we use real world travel demands data as inputs for our model. The objective function is to minimize the autonomous vehicle (AV) fleet size to meet the known travel demands. The constraints ensure that (1) each AV only serves one trip at any time (no ride sharing); (2) each trip can be served only once; and (3) the AV will have sufficient time to pick up the next rider after a delivery. The model is solved using genetic algorithm. The preliminary result shows that SAV can reduce the number of vehicles needed by 20% but the total VMT increases by 30%. Accordingly, we compare the life cycle environmental impacts of the SAV system to that of a traditional system considering the reduced car manufacturing needs, the more frequent turn-over of AV, the increased VMT, and the potential improvement of fuel economy due to autonomous driving. Implications from this study help understand how the autonomous vehicles may affect sustainable urban system and inform policy decisions for the development of SAV system.

Keywords: Shared autonomous vehicle, Optimal fleet size, Genetic algorithm

Improvement of copper (II) ions removal from aqueous solutions through biosorption using Sargassum loaded chitosan sorbent

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Abstract:

In Biosorption technology, marine algae have received significant attention as biosorbent in the removal of low-level toxic metals from industrial effluents and natural waters. Recently, Sargassum biomass washes up the Caribbean coast and affecting the region's economy. In this work, we have developed a chitosan sorbent loaded with locally available waste biomass Sargassum for the removal of copper (II) ions from aqueous solutions. Sargassum biomass was fine grounded, distributed homogenously in chitosan gel to form chitosan/Sargassum blended biopolymer beads. Batch adsorption experiments were conducted to study the influence of variable parameters such as contact time, pH, adsorbent dosage and metal ion concentration. The results were compared to pristine chitosan beads to investigate the influence of Sargassum biomass in picking up the metal ion under the same experimental conditions. Alginic acid and other compounds present in the Sargassum seaweed could act as additional binding sites other than amino and hydroxyl functional groups of chitosan for copper(II) ions. The results were applied to equilibrium models such as Langmuir and Freundlich to find the adsorption capacity and interaction mechanism between copper ions and biosorbent. Kinetic models such as Legergren pseudo-first order pseudo-second order were also applied to analyse the contact time data. The maximum monolayer adsorption capacity of chitosan and chitosan/Sargassum biosorbent was 250 mg/g and 1000 mg/g respectively. This indicates the significant improvement in copper ion uptake after loading marine alga on chitosan matrix due to the functional groups associated with Sargassum. Both chitosan and Chitosan/sargassum biosorbents were characterized by Fourier Transform Infrared Spectroscopy analysis before and after adsorption.

Keywords: Sargassum, Copper (II) ions, Biosorption

Using multi-objective water resource system optimization to improve synergistic benefits of water, food and energy nexus

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Abstract:

In recent years, understanding the water, food and energy (WFE) nexus has already become the shared foundation for many researchers, policy makers and stakeholders to manage the resource allocation and security of WFE systems. Moreover, the nexus approach could be integrated into decision making practice that could be used by policy makers to optimize these synergies and manage trade-offs. As the changes in the global environment have occurred, green energy, green environment, and other related concepts have become significant, but many countries still rely heavily on nuclear power. In Taiwan, there are averagely 3 to 5 typhoons striking Taiwan every year, accompanied with a large amount of rainfall that can be considered as an available water resource. However, the extremely large quantity of spilled water for merely flood control purpose has turned into a serious waste of water resources. Therefore, in order to improve the synergistic benefits of water, food and energy nexus, we propose to take advantages of climatic conditions in Taiwan to enhance the efficiency of hydropower generation while minimize the water shortage rate of long-term reservoir operation in the future by combining reservoirs with other usable water resource systems. Data of this study were collected from Taipei metropolitan in the past 5 years, including water consumption data, wet, general, rainfall and drought year etc. The Non-Dominated Sorting Genetic Algorithm (NSGA-II) was applied to searching for the total amount of hydropower generation, water allocation and the final reservoir storage. The results of this study demonstrate that the multi-objective reservoir operation strategy obtained from the NSGA-II incorporated with the back-up water resource of farm ponds can make effective water allocation in response to urban water demands and thus provide decision makers with reference guidelines for sustainable water resources management. We hope that the proposed intelligent water allocation system will pave the way to future research for integrated water resources management.

Keywords: WFE nexus, NSGA-II, Water resource system

Using artificial neural networks to simulate and predict PM2.5

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Abstract:

In recent years, fine particulate matter (PM2.5) has been a critical air pollutant in many developed countries. According to the perversely research, exposure to high concentrations of PM2.5 can cause serious health problems because PM2.5 contains microscopic solid or liquid droplets that are sufficiently small to be ingested deep into human lungs. Thus, precise daily simulation and prediction of PM2.5 concentration is notably important to regulatory plans that inform the public and social activities when injury events are foreseen. PM2.5 has also been legislated as an air pollutant in Taiwan in 2012. However, the generation of PM2.5 is very complicated, including natural sources and artificial sources. The mix of local sources and regional transportations makes the control of PM2.5 more difficult. Understanding the spatial and temporal characteristics of PM2.5 helps identifying its possible emission sources.

Artificial neural networks (ANNs) have the ability to approximate nonlinear functions and therefore have become valuable tools for handling various resources problems. Compared with the traditional air pollution dispersion model and ANN models, there are few studies using ANNs to conduct the simulation and prediction of PM2.5 concentration. The aim of this research is to use ANNs to simulate and predict PM2.5 concentration. The results present: (1) investigate and analyze the data already collected from the air-pollution monitoring network; (2) investigate the pattern changes of PM2.5 and other air pollutants in recent 20 years; and (3) conduct the simulation and prediction of PM2.5 concentration in Taipei. ANNs can produce much more accurate results than statistical regression models for the simulation and prediction of PM2.5, and especially useful when big data are available.

Keywords: Artificial neural networks, PM2.5 concentration, simulation, Prediction

Municipal solid waste sustainably available for energy use in China - Current status and future projection

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Abstract:

Moving towards a circular economy where waste is minimized and seen as resources that are recycled into new secondary materials requires changes throughout the product life cycles. Despite efforts on waste minimization, municipal solid waste (MSW) is still generated and energy should preferably be recovered from the residue not suitable for recycling rather than be landfilled. Efficient waste management plays a key part in delivering on many of the sustainable development goals and the Paris agreement. China is the most populous country in the world, with rapid increase in urbanization rates and economic growth, MSW quantities are surging. The majority of collected MSW in China is landfilled, which causes extensive environmental issues as well as representing a loss of precious materials and poor use of limited land resources. Shifting to a more sustainable use of MSW resources is high on the political agenda. This includes increasing recycling rates, expanding the recycling industry, and increasing waste incineration. Sorting practices are improved to facilitate recycling and there are massive investments in incineration plants to treat the heterogeneous MSW fraction not suitable for recycling. Investments in waste management infrastructure today shape the waste management systems of the future. A realistic and geographically detailed projection of available MSW quantities and characteristics is important to enable good planning and prevent lock-in in unsustainable waste management systems. An appreciation of the geographical spread of MSW resources, their composition, calorific value, and development is essential to assess to what degree MSW can be utilized in the energy system. This can serve as input in energy systems modelling to analyze how optimal use of MSW in the energy sector can contribute to an energy system based on clean energy. Regionally available MSW quantities and characteristics are assessed through statistical analysis and literature review. Policy analysis and forecasts for societal development are used to appraise tendencies and factors affecting MSW development, including population, urbanization, and growth development. A simple spreadsheet model is developed to project future MSW quantities sustainably available to the energy sector until 2050 and different scenarios are used to address uncertainty. The result is a mapping of currently available MSW resources in China and projected quantities and their characteristics on a regional level. Three scenarios are developed representing high, medium, and low recycling rates until 2050.

Keywords: Municipal solid waste, Energy system, China

Sustainable decision analysis of contaminated sediment remediation: A case study in the northern Taiwan

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Abstract:

Contaminated sediments may pose a threat to ecosystems and human health. However, sediment repair is often a time consuming process and requires high cost. Therefore, the decision-making process to start the restoration of contaminated sediment has received a lot of attention recently. Engineering-technical assessment alone may not be sufficient to initiate sediment remediation. The goal of this study is to develop a comprehensive assessment framework that addresses the environmental, economic and social aspects of the concept of green and sustainable remediation for the management of polluted sediments. This study proposed the framework that comprised a three-stage analysis, beginning with human health risk assessment (HHRA) of contaminated site, preliminary cost-benefit analysis (CBA), and ended with multi-criteria decision analysis (MCDA). MCDA was combined with life cycle assessment (LCA) for environmental aspect, CBA for economic aspect, then HHRA and public acceptance for social aspect to implement integrated and sustainable strategies for sediment management. The framework was applied to select the best sediment management alternative for the heavy metals contaminated sediment in the river of northern Taiwan. The pre-remedy HHRA results indicated an unacceptable cancer risk to the children, whose mean cancer risk in all the sampling sites was 1.29E-06 through pathways of ingestion and dermal contact. The results of preliminary CBA showed that the net present value of remediation project was 1.59 billion TWD, indicating its economic feasibility. For the sustainability assessment of sediment remediation, the results of MCDA revealed that the cost of in situ capping anthracite activated carbon (AC) strategy had relatively lower cost, lower human health risk after remediation, and high public acceptance, but higher environmental impact, when compared to the method of dredging and soil washing. In this case study, in situ capping anthracite AC was identified as the preferable remediation alternative with comprehensive aspects. The proposed framework can provide decision makers to choose integrated strategy for contaminated sediment management. In this case study, in-situ capped anthracite AC was considered to be a comprehensive restoration option. The proposed framework can provide policy makers with a comprehensive strategy for the management of polluted sediments.

Keywords: Contaminated sediment remediation, Activated carbon, sustainability assessment

Urban water footprint accounting with GIS-based high resolution

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Abstract:

Water scarcity has become one of the major concerned issue throughout the world, which is currently aggravated mainly due to climate change, global population growth, urbanization and industrialization. Among them, urban regions are the most densely populated area and are more susceptible to depletion of water resources than other areas. Therefore, water resource management can be crucial in solving urban water scarcity issues by identifying spatial hotspots of water consumption and formulating respond strategies in the corresponding hotspots. Urban water footprint (WF) accounting is an emerging method that provides comprehend information of urban water consumption by analyzing the spatial variation of blue, green and gray water footprint in the city, allowing higher efficiency in urban water resource management. However, previous approaches of urban WF accounting are limited due to data availability and the spatial resolution of data. This study aims to establish a bottom-up approached urban WF accounting framework and explores urban WF of Taipei city with high spatial resolution characteristic by integrating land use map, spatially detailed water consumption data and meteorological data based on geographical information system (GIS). The WF accounting results show that commercial and institutional buildings are the main blue WF hotspots in the city. Moreover, considerable amount of grey WF of tap water indicates that WF of Taipei city is highly affected by the water quality of wastewater and ambient water quality regulation. The visualization of WF accounting results also reveals that many blue WF hotspots of rainwater could be recycled and reused to reduce tap water consumption in a sustainable way; hotspots of grey WF of rainwater also suggest that urban runoff should be further treated to reduce the river's pollution load. The relationship of spatial pattern of WF and socioeconomic factors was also discussed. This study seeks to present an integrated urban water footprint assessment with an intuitive WF quantification method, and combining it with spatial characteristics to enhance the adaptability of the city faced with the impact of water resource depletion.

Keywords: Water footprint, GIS, Taipei city

A quantitative study on the immobilization and detoxification of copper by aluminate spinel

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Abstract:

Copper-laden-sludge is one type of hazardous solid wastes generated during the development of industrial activities, and has possessed serious impact on environmental conditions. Our previous studies have reported the strategy of incorporating the hazardous copper in a $CuAl_2O_4$ spinel structure through sintering the copper-laden sludge with Al-rich ceramic raw materials. The $CuAl_2O_4$ spinel shows much lower copper leachability under acidic environments compared with CuO, which confirmed the effectiveness for copper immobilization while simultaneously reuse the copper-laden sludge for ceramic products. However, although the copper can be immobilized in the spinel structure, the long-term copper leachability is also important to further evaluate the safety of the ceramic products. Therefore, a quantitative study was carried out to explore the leaching and dissolution behavior of the spinel phase, and the detoxification effect after spinel formation was also evaluated through bio-adhesion experiment. Firstly, the $CuAl_2O_4$ was successfully generated after sintering the copper-laden alumina, which confirmed the potential for copper incorporation during ceramic sintering process. To explore the leaching behavior of the $CuAl_2O_4$ spinel, the pure $CuAl_2O_4$ was prepared for a series of leaching experiments. A 22-day leaching was carried in fluid of pH around 4.93 (prepared according to the standard TCLP method, U.S. EPA., 1992), which is close to natural environment. According to the metal leaching results, Visual MINTEQ was used to calculate the speciation of metal ions in leachates. Results showed that the total leached copper concentration from $CuAl_2O_4$ was less than 0.06% and reached equilibrium in 10 days, while that from CuO was much higher. The Cu/Al molar ratio in leachates is higher than the theoretical stoichiometric of $CuAl_2O_4$. According to the calculation on Visual MINTEQ model, almost all copper ions formed complexes with only Ac-, while most of aluminum form Al(OH)Ac+, which represents an incongruent dissolution. Thus, a hydrated layer may form as the ion exchange occurred between copper ions and hydrogen ions, which increase covalently-bonded network formation and then reduce the dissolution rate. Finally, bacterial adhesion experiment was chosen to analyze the detoxification effect of spinel, and the average density of alive adhered bacterial on the surface of $CuAl_2O_4$ is surpass that on the surface of Al_2O_3 and CuO.

Keywords: Copper, Spinel phase, Visual MINTEQ model

The impact of natural resources dependence on public education investment

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Abstract:

Education is one of the driving factors of economic sustainable development. The crowding out effect of natural resources dependence on public education expenditure is one of the mechanisms of resource curse. Based on China panel data of 31 provinces, the empirical study found that the relationship between natural resources dependence and public education expenditure was negatively correlated, which shows the existence of the crowding out effect of natural resources dependence on the public education expenditure, and from the economic point of view, the crowding out effect is relatively large. Further, the sample is divided into eastern regions and central and western regions. The results show that the crowding out effect of natural resources dependence on public education expenditure exists only in the central and western regions.

Keywords: Education expenditure, Crowding out effect, Natural resources dependence, Panel data

Effect of crumb rubber and broken glass on permanent deformation behaviour of unbound granular aggregates

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Abstract:

Recently, one way to preserve virgin and non-renewable resources is the application of recycled waste materials in road construction and rehabilitation processes. It also can solve management problems related to the expansion of landfills. This paper aims to study the possibility of using different waste materials for unbound layers (base and/or subbase) of road pavements. Two waste recycled aggregates of recycled concrete aggregate (RCA) and crushed rock (CR) from construction and demolition wastes (C&D) were considered as main course aggregates, and then crumb rubber (with particle sizes ranged from 400-600 μm) at 1% of dry weight of each aggregate together with broken glass (by nominal size of 5 mm) at different percentages of 1, 3 and 5% (by dry weight of aggregates) were added to the samples. The repeated load triaxial tests were then performed on the samples to study the feasibility of using the waste materials in terms of permanent deformation behaviour of the CR/RCA with broken glass and crumb rubber.

Keywords: Recycled concrete aggregate, Crushed rock, Deformation behavior, Rubber and glass

Life cycle environmental impacts of light duty electric vehicles

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Abstract:

Electric vehicles (EVs) are a key greenhouse gas and pollution mitigation strategy, but life cycle assessment (LCA) of EVs has shown that the manufacture of EVs, particularly lithium ion batteries, requires significant inputs of energy and materials. The basis of early EV LCAs were often vehicles with around 28 kWh battery capacities, shorter range, and efficiency-oriented designs. Since these first EV LCAs were conducted, EV technologies and the EV market have evolved considerably. U.S. sales data for EVs shows a trend of increasing battery capacity of more than four kWh/year on average. This increase is likely due to a variety of factors, including the decreasing cost of batteries, the proliferation of EV models, designs that respond to range anxiety, and the growth of the luxury and sport-utility vehicle sectors. This trend is highlighted by Tesla models, which have the largest batteries in the market, making up the nearly 80% of the total battery capacity deployed in the US market when weighted by monthly sales of different models. As the market for EVs matures, the energy densities of batteries increase, and the cost continue to fall, larger battery systems are likely to be found in an increasingly wide array of EV classes.

The research presented here seeks to understand how trends in larger battery capacity and consequent (or causal) design choices affect life cycle GHG emissions of EVs. The specific questions answered by this research include:

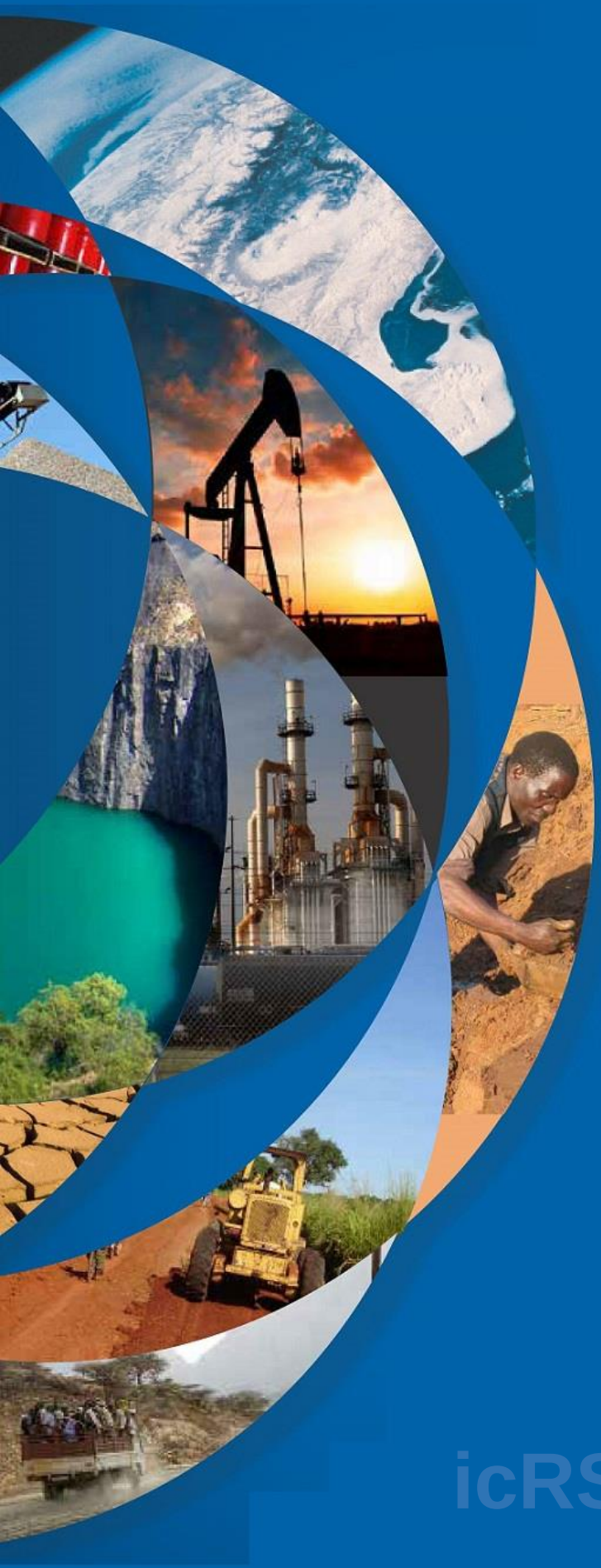
1. What are the life cycle impacts of increasing battery capacities for efficient, long-range EVs; for EVs that are designed for performance and luxury instead of efficiency; and for larger EVs such as sport utility vehicle (SUVs)?

2. Are there unanticipated consequences of larger battery capacities and vehicle design choices, such as significant improvements in battery life?

A model was developed that simulates three archetypal vehicle designs based on current market trends: an efficiency-oriented vehicle with significantly increased range (e.g., Chevy Bolt); a high performance luxury sedan with long range and high performance (e.g., Tesla Model S); and a SUV (e.g., Tesla Model X). Combining life cycle inventory data for vehicle production and fuels, FASTSim for vehicle use phase modeling, and a battery LCA model that includes cycle life modeling, we generate expected life cycle impacts for each vehicle type.

One particular insight from this modeling is that larger battery systems can also enable improved battery cycle life. Thus larger battery systems may be able to stay in service longer without replacement, and/or have more residual utility in a secondary application.

Keywords: Electric vehicles, Life cycle assessment (LCA), Battery systems, Tesla



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