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Lessons learnt from synergies and trade-offs between SDGs at the sub-national scale

RESEARCH BRIEF

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This document is the first of two project briefs being developed as part of the ‘'Living laboratories for achieving sustainable development goals across national and sub-national scales' (known for short as the **‘Luanhe Living Lab’**) project that is funded by NERC (UK), NSFC (China) and JST (Japan). The overarching aim of the research is to provide scientifically-grounded, policy-relevant information on the synergies and trade-offs between selected sustainable development goals and targets within the Luanhe River Basin in China.

This research brief is targeted at the international research and policy-making community and was presented at the International Forum for Sustainable Asia and the Pacific (ISAP) on 10th November 2020. The project team are grateful to local and regional stakeholders for providing constructive comments on draft versions of this brief.

Project Website *https://luanhelivinglab.home.blog/*

Related SDG interactive tool: *https://sdginterlinkages.iges.jp/luanhe/index.html*

Cover image: The Luanhe river as viewed from Chengde County (40°46'14"N, 118°08'55"E).

Source: Photograph by the Luanhe Living Lab team, 10th October 2019.

KEY MESSAGES

The Sustainable Development Goals (SDGs) adopted by the General Assembly of the United Nations in September 2015 are currently driving most development policies globally. With 17 goals, 169 targets, and 231 unique indicators to monitor and track progress of, countries may lose sight of the synergies and trade-offs between goals and targets. To address this concern, approaches are being developed to identify and quantify synergies and trade-offs at the national level (Nilsson et al., 2016a,b; Zhou, et al., 2018; Zhou and Moinuddin, 2017), but there has been a limited focus at the sub-national scale.

This research brief is an initial output from the 'Luanhe Living Lab' project that sets out to understand how national level policies related to the SDGs impact development at the sub-national scale. This research brief provides a range of important observations related to how development inequalities can be influenced by national policies. The observations are based on a case study in the Luanhe River Basin (LRB), China but are highly relevant to other river basins.

Target audience: members of the international research and policy-making community, especially those who are responsible for shaping policy related to the SDGs at national and sub-national scales.

Key observations:

- Our simulations demonstrate that large areas of forests in the LRB represent the largest carbon stores in both vegetation and soil. The ***implementation of future ecological restoration projects and protection policies could be an important component of climate change mitigation strategies for the attainment of the SDGs*** and thus should receive greater attention.
- Forests not only occupy the largest areas in the LRB, but also represent hotspots for all ecosystem services, meaning that forests should be the land use type of greatest concern for the land management of the LRB. A series of ***policies promoting afforestation which have been implemented since 2015 in the LRB for biodiversity conservation and sand fixation, are promising and should continue to be implemented*** in the future, or even the formulation of more ambitious greening or afforestation policies could be considered in the future. However, ***a sustainable tradeoff needs to be preserved to maintain other provisioning services such as food*** which remains important given the rapid urban expansion taking place in the region.
- The basin is currently suffering from both quantity- and quality-induced water scarcity problems and this problem will probably get worse in the future due to agricultural intensification, urban expansion, potential growth of iron and steel industrial capacity and climate change impacts on both precipitation and water loss. The equity of water distribution in the LRB is likely to be problematic for a long time to come. Special attention to ***environmental management and sustainable land system design should be directed to reducing water pollution and encouraging water conservation*** to achieve the SDGs.
- The built-up land areas, which correspond to ecosystem disservice hotspots, are projected to increase under future land use scenarios. In order to minimise the negative impacts on human well-being, ***planning policies that aim to balance urban expansion and ecological protection in the LRB should be implemented***. For example, increasing the surface area of land within nature reserves in urban and peri-urban areas should be considered.
- ***Local context is important. The inclusion of a diverse range of local and regional stakeholders in this study has been essential for better understanding possible trade-offs between national/regional (top-down) requirements*** with a view to maximising the synergies with local needs and plans. For example, a comprehensive policy package including reasonable water distribution, eco-compensation and coordinated protection measures was suggested to ***address the trade-offs with constrained economic growth and unemployment caused by national land-use planning for the protection of water resources and associated restrictions for development activities*** in the mid-and upstream. Policy guiding the implementation of equitable payment for ecosystem services and adequate mechanisms to promote the absorption of unemployed labour force from the mid- and upstream by relevant downstream sectors should be included as an integral part of the comprehensive policy package. ***Working with local stakeholders has helped the team to evaluate and validate the usability of project outputs*** (i.e. policy briefs, maps, guidance) to ensure they are appropriate for adoption by local stakeholders.

Towards better understanding of the synergies and trade-offs between SDGs

The Sustainable Development Goals adopted by the General Assembly of the United Nations in September 2015 are currently driving most development policies globally. With 17 goals, 169 targets, and 231 unique indicators to monitor and track progress of, countries may lose sight of the synergies and trade-offs between goals and targets, a fact that is readily acknowledged (Nilsson et al., 2016a). Understanding how the goals/targets interact is extremely important to:

1) minimise trade-offs and maximise synergies;
2) avoid wasting resources; and
3) ensure equitable partnerships and ultimately, equitable development internationally, at the national scale and within countries.

To address this concern, approaches are being developed to identify and quantify synergies and trade-offs at the national level (Le Blanc 2015; Niestroy 2016; Nilsson et al. 2016; ICSU 2017; UNESCAP 2017; Zhou and Moinuddin 2017; Millennium Institute 2018; OECD 2018; Weitz et al. 2018; Zhou et al. 2018 and 2019; Allen et al. 2019; European Commission 2019; Miola et al. 2019), but there has been limited focus at the sub-national scale. Within large countries, sub-national considerations are important as climatic, ecosystem, land-use and political sub-divisions are rarely coincident leading to interactions between the goals that may be quite different from those observed at national scale.

The rationale

Land use and land use change are anthropogenic drivers influencing climate change, aquatic and terrestrial ecosystems, disaster risk, livelihoods, human settlement, economic growth (in particular productive agriculture) and social systems (agriculture and non-agriculture employment, tenure system, etc.) in terms of both temporal and spatial scales. These drivers can cause wider and long-term indirect impacts: for example, loss in livelihoods can drive persistent poverty. Sustainable land use and planning is therefore an essential basis for achieving SDGs 1 (No Poverty), 2 (Zero Hunger), 5 (Gender Equality), 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 11 (Sustainable Cities and Communities), 13 (Climate Action) and 15 (Life On Land). Achieving one purpose of land use may undermine achieving other purposes. Also, land use and land use change in one region may impact on other regions. For example, forest clearance for agricultural farming in the upstream can adversely impact on freshwater access and use in the downstream areas and exacerbate landslide and flood risks locally and flood risk throughout downstream parts of the catchment.

In addition, national policy for addressing a specific issue, such as conservation of river sources by designating protected areas for selected major rivers, will constrain land use and associated development in the upstream water source areas. Without proper compensatory policies in place, such as for example, payment for ecosystems services through collection of water tariffs in the downstream areas, upstream areas will suffer from the trade-offs from the national policy implementation.

The research

The overarching aim of this research was to provide scientifically-grounded, policy-relevant information on the synergies and trade-offs between selected sustainable development goals and targets at the sub-national level. It is hypothesised that trade-offs between SDG goals and targets at the sub-national scale create inequalities between segments of society when attempting to achieve the SDGs at the national level. The river basin scale is the unit of analysis adopted to represent the sub-national scale in this research and constitutes an ideal geography for the study of human-environment interactions as cause-effect relationships related to human activities can be investigated within clearly defined physical boundaries.

In this research, we worked in China's Luanhe River Basin (LRB) as a sub-national level case study to investigate how land use and land use change impact on flood risk and ecosystem services and disservices and more broadly at SDGs 6, 7, 11 and 13, with potential additional relevance to Goals 1, 2, 8 and 15. To test the hypothesis and achieve the main research aim, four specific objectives were addressed.

- First, **future land-use change scenarios** have been developed for the LRB. This component has been participatory by engaging with different levels of stakeholders, ranging from regional leaders to representatives of national authorities, supplemented by analysis of historical land-use changes in the basin as influenced by past and current policies. Land-use change scenarios have served as a basis for all subsequent research activities in the project.

- Second, sediment budgets and flood risk were modelled for the different land use change scenarios. The **modelling specifically accounts for the effects of rapid urbanisation in the basin as well as aspects of reservoir operation**. Model outputs have been used to analyse and quantify the impact on future flood risk, long-term sediment budget, and water quality, and therefore supports the identification of trade-offs between different SDGs.
- Third, **ecosystem services and disservices for different land uses and land use change scenarios** have been analysed for the entire basin. This analysis used participatory approaches, notably expert panels. Changes in ecosystem services have been visualised for the different scenarios.
- Finally, the **SDG Interlinkages Tool**, which was developed by IGES, is being extended to operationalise it at the basin scale and visualise the synergies and trade-offs between the selected SDGs across various counties in the LRB. This will be achieved by incorporating results from all other specific objectives above and presented in the second Policy Brief**.**

The Luanhe River Basin as a living laboratory

The LRB covers an area of approximately 45,000km^2 in the northeast of the North China Plain (see Figure 1). The basin is located across three provinces: Inner Mongolia Autonomous Region, Hebei province and Liaoning province and contains three main types of landforms: a plateau, mountains, and a plain. The LRB is an important water supply source for Tianjin city, a large metropolis with a population of over 15 million people. Furthermore, the LRB also provides the water for the cities of Chengde, Zhangjiakou, Tangshan and Qinhuangdao in Hebei province. The LRB has a temperate semi-arid continental monsoon climate, with average annual precipitation of between 400–700mm per year (depending on location), most of which occurs from June to September. The LRB has a population of 5.4 million with a population density of 122 persons/km^2 (Bi et al. 2018).

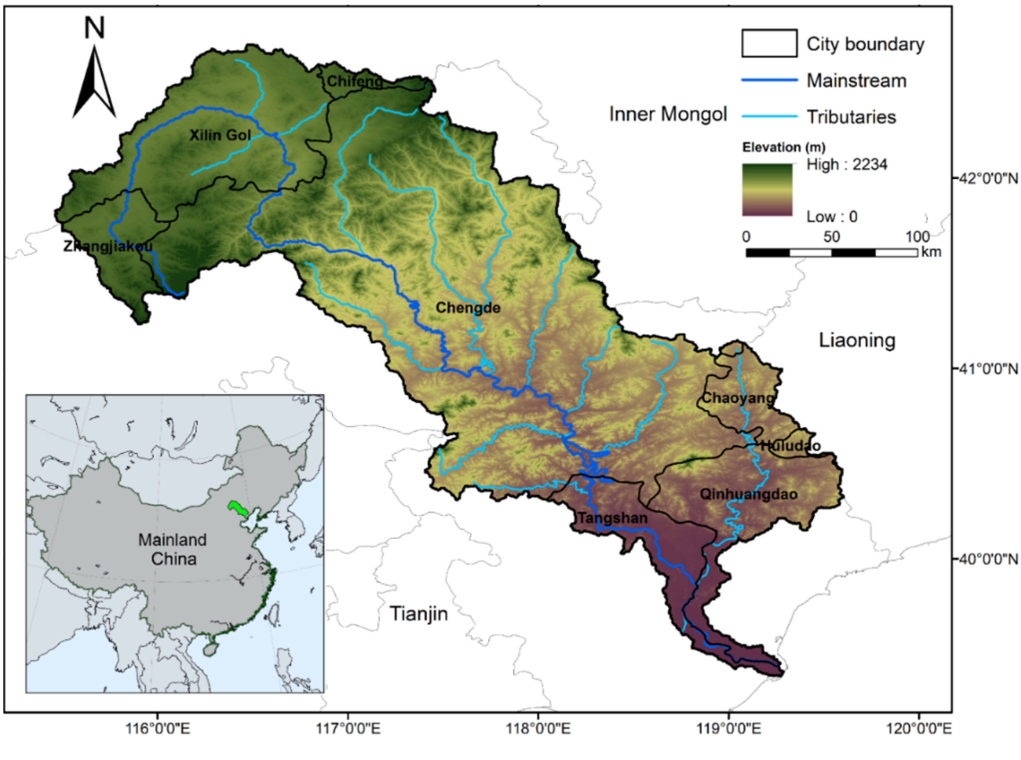

Figure 1: Luanhe River Basin, China

Since the 1960s, the LRB has become the key 'water source' of Beijing and Tianjin through water storage and diversion projects. At the end of the 20th century, the upstream of the LRB was defined as an important 'wind and sand defence area' of Beijing and Tianjin. National and regional policy such as the "Beijing-Tianjin sandstorm source control project", "Three-North shelterbelt project" and the "Ban on the cage fish farming in Panjiakou reservoir" have been implemented for preserving the ecological functions of freshwater provision and to prevent sandstorms. However, subsequent economic activities such as animal husbandry, modern industry and mining industry in upstream regions, and cage fishing in the midstream have become restricted. According to Tian (*et al.* 2019) and local Statistical Yearbook (2018), the distribution of economic development of the LRB area is imbalanced; the GDP of the whole river basin in 2017 was 605 billion Chinese Yuan (CNY); however, the GDP of the upper and middle streams in the LRB is only 131 billion Chinese Yuan (CNY) even though 65% of the LRB's inhabitants live in these regions.

Key findings of the study

Identifying land-use change scenarios

Land use and land cover are the most important criteria used to evaluate the environment and terrestrial ecosystem changes. A more holistic understanding of the complexity of land use and land cover will lead to improved future land use management strategies and a framework for the attainment of the SDGs in the LRB. In this study, land system (combinations of land cover and land use intensity) of the LRB has been classified based on: (1) land use and land cover; (2) livestock; and (3) agricultural intensity in the LRB. Land use and land cover represents the composition of the landscape, while livestock and agricultural intensity data represent important characteristics of land management and farming systems.

The upper reaches region of the LRB is mainly covered by grassland, and the middle-lower reaches region is mainly covered by temperate forests, while the croplands and urban areas are located towards the eastern plains. Four scenarios: *Trend*, *Expansion*, *Sustainability*, and *Conservation* were designed based on different socioeconomic development and environmental protection targets, local plans and policies, and the information from stakeholders to explore land system evolution trajectories of the LRB and major challenges that the river basin may face in the future (Table 1). The study period was selected as 2015 to 2030 to ensure temporal consistency of different datasets and align with the SDG targets' achievement date.

Table. 1. The four land use change scenarios

	Scenarios	Description
A	*Trend*	Business as usual
B	*Expansion*	High-speed economic development. Marking the upper end of the scenario literature in fossil fuel use, food demand, energy use and greenhouse gas emissions.
C	*Sustainability*	Emphasis on economic growth shifts towards a broader emphasis on human well-being.
D	*Conservation*	The socioeconomic context of the *Sustainability* scenario was used as a baseline for the *Conservation* scenario and extended by the implementation of the ecological restoration and protection policy targets (e.g. afforestation).

Modelling results (Fig. 2) indicate that land system changes varied under different land management strategies:

1) By 2030, the area of cropland in the LRB will not change, and the area of grassland will increase slightly (average by 5.5%), but they will both experience agricultural intensification and urban growth under all four scenarios. In the future, the area of intensive cropland will almost double and the area of grassland with high livestock density will increase as much as fivefold in the future;
2) The cropland intensity and the urban growth rate were much higher under the historical trend (*Trend*) scenario compared to those with more planning interventions (*Expansion*, *Sustainability*, and *Conservation* scenarios);
3) The most significant increase of livestock density in grassland is projected under the Expansion scenario;
4) Both quantity- and quality-induced water scarcity problems in the LRB are likely to increase under all the scenarios; and
5) As the most afforested river basin in North China, the LRB plays a significant role in storing and capturing carbon and mitigating carbon emission. Average estimated carbon density in the LRB was 128 MgC ha^{-1} in 2015, which is 1.2 times China's average of 107 MgC ha^{-1}. Carbon storage will increase under the *Conservation* scenarios but decrease under all other scenarios (*Trend*, *Expansion*, and *Sustainability*) by 2030.

Policy recommendations:

1) The basin is suffering from both quantity- and quality-induced water scarcity problems currently and this problem will probably get worse in the future due to agricultural intensification, potential expansion of iron and steel industrial capacity and urban expansion. The equity of water distribution in the LRB will be a serious issue for a long time to come. Special attention to environmental management and sustainable land system design should be directed to integrating reducing water pollution and encouraging water conservation to achieve the SDGs.
2) Our simulation demonstrates that the large areas of forests in the LRB represent the largest carbon storages

in both the vegetation and the soil in the future, and the implementation of future ecological restoration projects and protection policies could be a quantitatively important component of climate change mitigation strategies for the attainment of the SDGs and thus should receive greater attention.

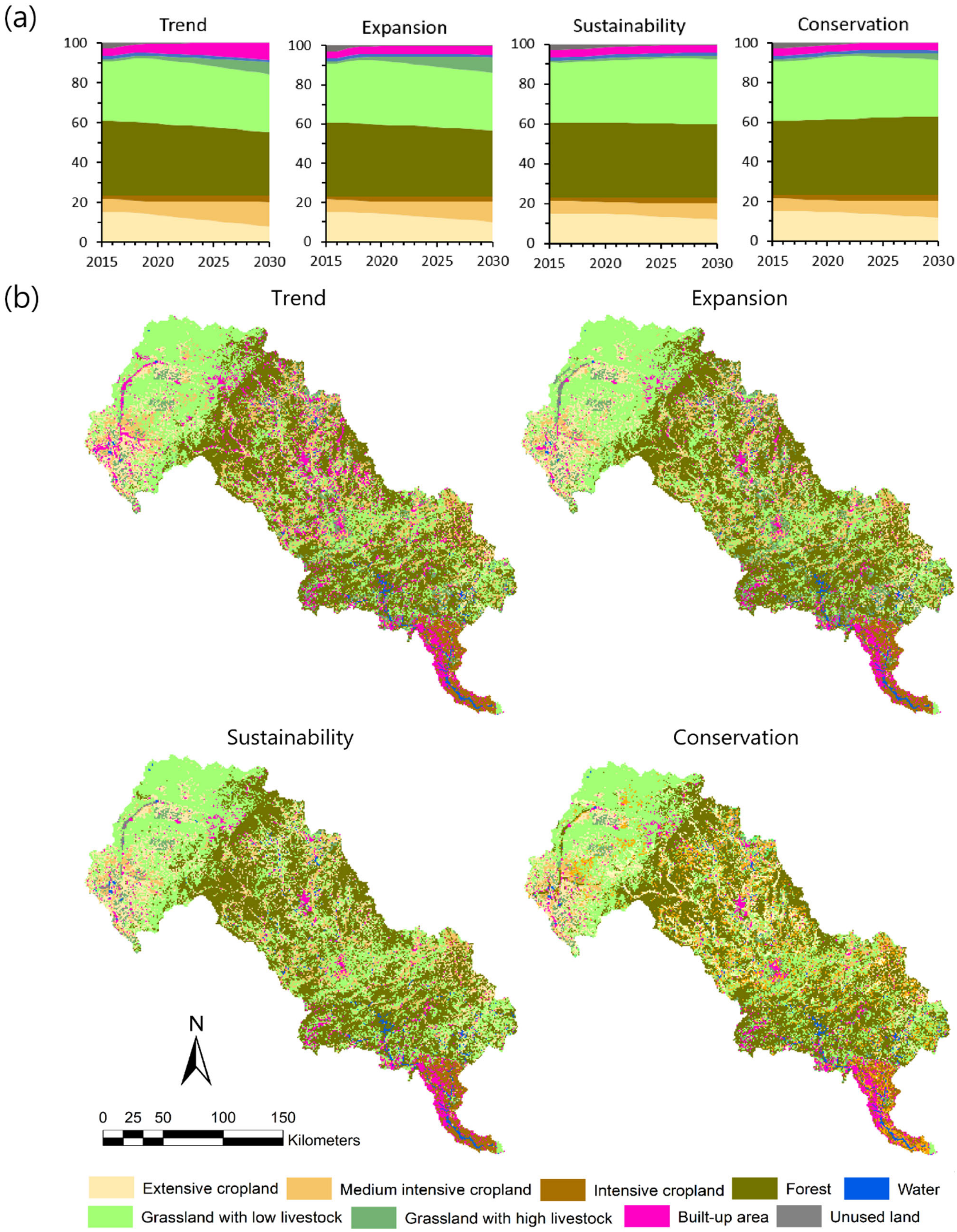

Figure 2: Land system change from 2015 to 2030 in the LRB under different scenarios. (a) Quantitative change. (b) Land system maps in 2030.

Impact evaluation of land use change on flood risk

Land use/cover changes in the LRB have a significant impact on rainfall infiltration and water retention capacity of the natural environment. For example, flood peaks, soil erosion and non-point source pollution may all increase due to natural lake shrinkage and wetland degradation as a result of human activity and climate change. Climate change is also changing the frequency, intensity, and distribution of extreme weather events. These factors, combined with increased exposure to flooding as a result of population growth and intensifying human activities, may significantly increase flood risk. In order to achieve the SDGs, it is crucial to understand the changing flood risk in the LRB caused by climate change under different development strategies (land-use change scenarios). For this purpose, a high-performance hydrodynamic model, HiPIMS, is used to simulate and assess future flood risk under different land use change and climate change scenarios in LRB.

This study followed four steps:

1) Processing data and setting up the HiPIMS for flood simulation in the LRB;
2) Simulating a historical extreme flood event to calibrate HiPIMS by comparing the model results with remote-sensing inundation extents (Figure 3);
3) Assessing the future flood risk under different land-use change scenarios including development and operation of key flood mitigation infrastructure such as dams and reservoirs; and,
4) Investigating the impact of climate change on flood risk in the LRB.

The flood impact/risk information will be presented by quantifying flooded areas of different land use types and identifying impacted properties and infrastructure, which is used to inform the development of the SDG Interlinkages Tool and provide policy recommendations. From the research, it is found that: 1) climate change may lead to up to 10% of uplift on rainfall intensity by 2030; and, 2) different land use change scenarios have different level of impact on future flood risk in the LRB. It is essential to consider the impact of climate change and the altered risk of flooding and other natural hazards when developing future development strategies for the basin.

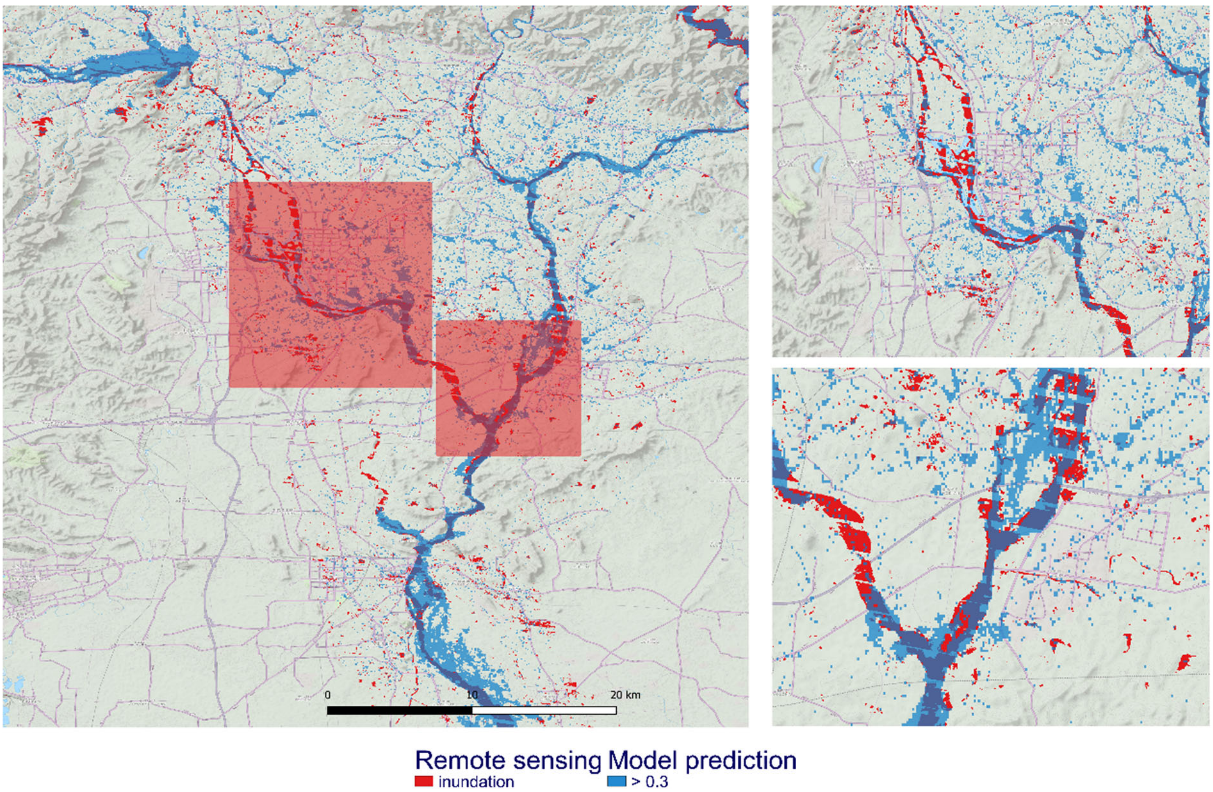

Figure 3. HiPIMS simulation of a historical flood event: comparison between the predicted (blue) and remotely sensed / observed (red) flood extents; zoom-in view of Qianan City and Lulong City (right panel).

Understanding the role of ecosystem services and disservices

Ecosystem services are a useful framework to communicate and analyse the ecological and socio-economic impacts of changes in land-use. Most SDGs benefit to some degree from ecosystem protection, restoration, and sustainable use. Assessing ecosystem services and ecosystem disservices, for the Luanhe river basins, helps understand the human-environment interactions for achieving SDGs. Expert-based ecosystem services capacity matrices were used to evaluate ecosystem services and disservices in the LRB. Capacity matrices are widely used for assessment of ecosystems services, and are based on participatory approaches. A capacity matrix consists of a look-up table that links land cover types to ecosystem services potentially provided. In total, we have collected 25 capacity matrices from a wide range of experts. Among these, 15 were completed during a focus group workshop which was held in October 2019 at Nankai University in Tianjin, while the other ten matrices were completed through an email survey in August 2020. During the workshop and email survey, experts were asked to fill in the capacity matrices for scoring each ecosystem services and ecosystem disservices in the LRB (see Box 1 for definitions). The expert panel represented different disciplines, universities, institutions and agencies who were familiar with the environmental issues and policy in the Luanhe River Basin.

Box 1: What are ecosystem services and disservices?

Generally, Ecosystem Services are the goods or services provided by ecosystems that directly or indirectly benefit humans (Millennium Ecosystem Assessment, 2005; Kumar 2010). Examples include fresh water supply service provided by river, flood regulation service provided by wetlands, and recreation service provided by a forested landscape.

Ecosystem Disservices are the ecosystem-generated functions, processes and attributes that result in perceived or actual negative impacts on human well-being e.g. invasive species, forest fires (Shackleton et al. 2016).

Box 2: What are ecosystem services hotspots and coldspots?

Ecosystem services hotspots are defined as regions with high service diversity, high biophysical or monetary value of services, or high capability of supplying services; the opposite features are defined as coldspots (Cimon-Morin et al. 2013, Schröterand and Remme 2016).

Key findings (also refer to Figure 4):

1) Provisioning services hotspots (see Box 2) are widespread in the upper-middle reaches including woodlands (i.e. forests, nursery and orchard), and waterbodies including lakes and reservoirs. Cold spots are distributed across unused lands, and built-up areas which are mainly concentrated downstream;
2) Regulating services hotspots are also widespread in the upper-middle reaches including forests, lakes, and reservoirs. Cold spots were also distributed in the bare lands, and built-up land areas;
3) Cultural services hotspots are not only widespread in the forests in the upper-middle reaches, but also distributed around the lakes. The cold spots are located around bare lands;
4) Ecological integrity hotspots are concentrated in the forests and lakes, while cold spots are distributed in the built-up land areas and the bare lands, rock or gravels; and,
5) For ecosystem disservice, hotspots are concentrated in the built-up land areas and the rainfed cropland.

Policy recommendations:

1) The forests not only occupy the largest areas in the LRB, but also represent hotspots for all the ecosystem services, meaning that forests should be the land use type of greatest concern in the land management of the LRB. The upper part of the LRB was defined as an important 'windbreak and sand-fixing area' of Beijing and Tianjin. A series of policies promoting afforestation which have been implemented since 2015 in the LRB for sand fixation and biodiversity conservation, such as 'National Forest Management Planning (2016-2050)', 'Land greening planning of Hebei Province (2018-2035)', 'Implementation plan of afforestation in Zhangjiakou city and Chengde Bashang area of Hebei Province' are promising and should continue to be implemented in the future; more ambitious greening or afforestation policies could also be considered in the future. However, for promoting afforestation and protecting downstream regions from wind and sandstorm, animal husbandry, agriculture activities, and the mining industry in upstream regions should be limited. This inevitably has an impact on the livelihood pattern of farmers and herdsmen, and as a result, affects the economic development of upstream regions. A trade-off needs to be preserved to maintain key provisioning services such as food which remains important given the rapid urban extension taking place in

the region. A sustainable ecological compensation mechanism between upstream and downstream regions for increasing financial transfer payments to upstream ecological protection areas should be refined and effectively implemented.

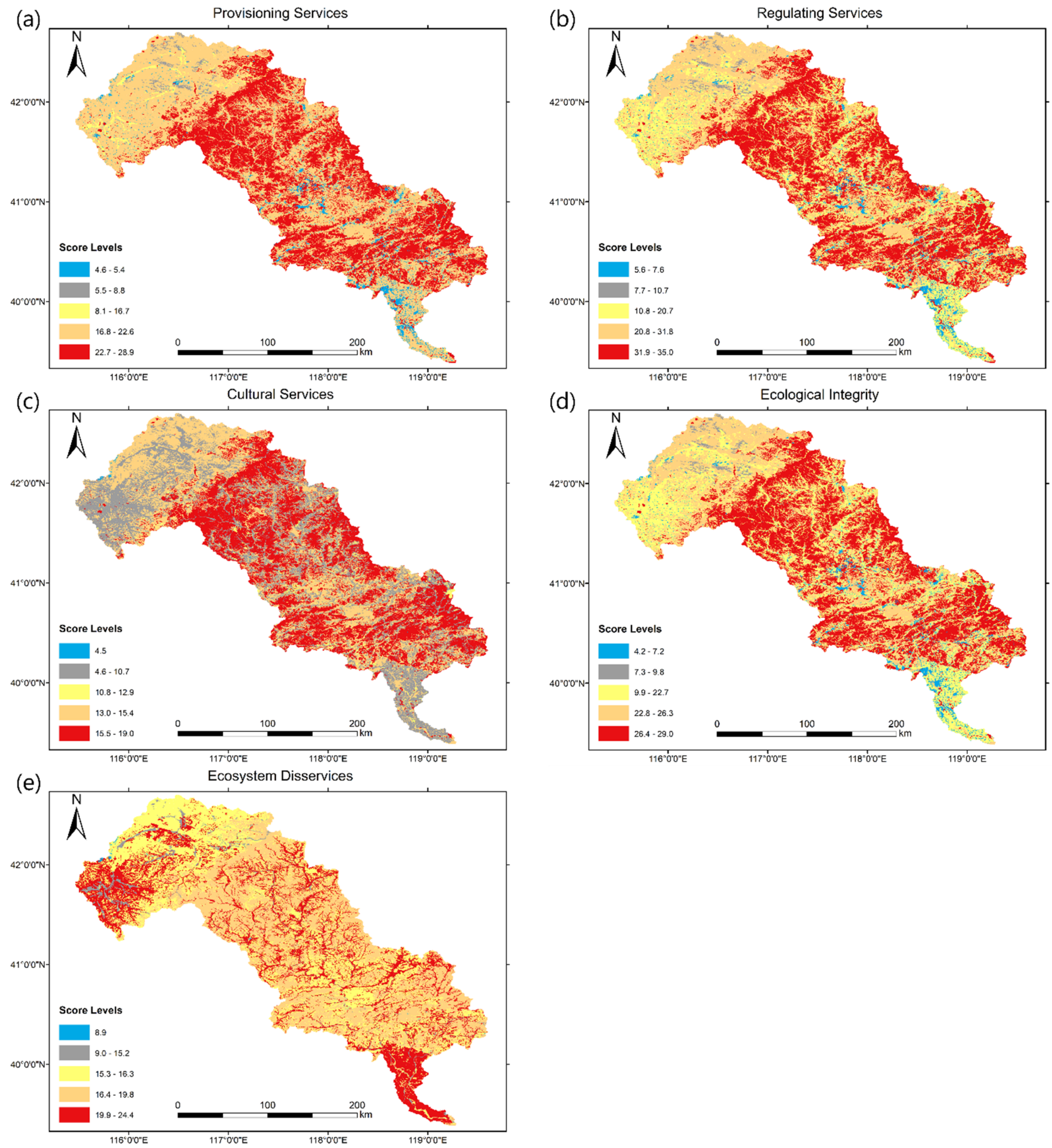

Figure 4: Maps showing score levels of provisioning services, regulating services, cultural services, ecological integrity and ecosystem disservice in the LRB.

2) Water bodies also play important roles in provisioning services, regulating services, cultural services and ecological integrity, particularly in terms of freshwater provision. Since the 1960s, the LRB has become the 'water source' of Beijing and Tianjin through water storage and diversion projects. However, ecological compensation has not been fully implemented. Chengde city and Qianxi County of Tangshan city have sacrificed local economies for providing high-quality water (e.g. ban on cage fish in Panjiakou and Daheiting reservoirs), but they only received limited compensation from Tianjin's high domestic water price income. The mechanics of trans-provincial eco-compensation schemes between Tianjin and Hebei should be established and effectively implemented to maintain the engagement of residents and government in water sources areas to protect the water quality.
3) The built-up land areas, which correspond to ecosystem disservice hotspots, are projected to increase under future land use scenarios. In order to minimise the negative impacts on human well-being, planning policies should aim to balance urban expansion and ecological protection in the LRB. For example, increasing the surface area of land under nature reserves in urban and peri-urban areas should be considered.

Potential synergies and trade-offs between the SDGs for this study

To unveil the human-environment interactions at the river basin scale, the Driving force-Pressure-State-Impact-Response (DPSIR) model was used in this study to build cognitive understanding of the cause-effect relationships among human activities, the environment and society responses. The DPSIR model was derived from the PSR model originally developed by the Organisation for Economic Co-operation and Development (OECD) to structure environmental indicators and related reporting works (OECD, 2003). Human activities as drivers exert pressures on the environment and consequently cause changes in the state of the environment, including the quality of the environment and the quantity and quality of natural resources. Society responds to those environmental concerns that are considered significant through through mitigating, adapting to, or preventing human-induced negative effects on the environment.

In this study, a simplified Driver-State-Impact-Response (DSIR) framework was used to model the interactions among human activities, the hydrological cycle and water resources, impacts on social and economic development and policy responses. The frameworks recognises that these interactions are not on a linear loop, and thus the feedback interactions, within and among the four pillars of DSIR, are also modeled. Based on a comprehensive literature review, major interactions in the context of river basin management and development were identified and mapped to the relevant SDG targets. These were further aligned with the four pillars. The results from the literature review were further validated based on the expert judgement from the project team (see Figure 5).

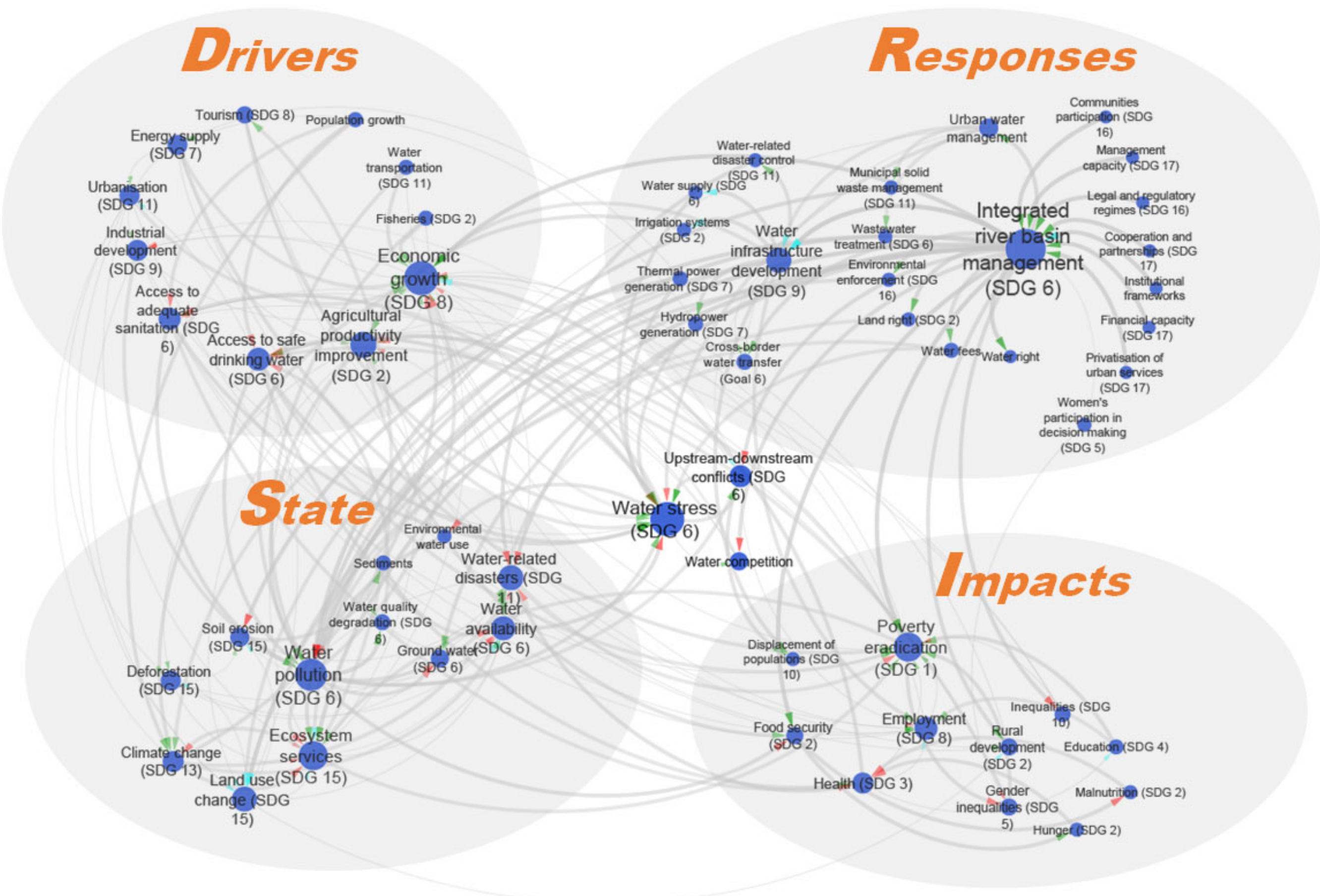

Figure 5: Conception of SDG synergies and trade-offs in the context of river basin management and development

Note: Each line with an arrow indicates a causal link between the paired elements. A red arrow indicates a potential trade-off and a green arrow indicates a potential synergy. An arrow in fluorescent blue indicates the link can be either a trade-off or a synergy. The size of the nodes reflects the number of links the node has.

For a river basin, the key drivers to the environmental changes related to the hydrological cycle include, population growth, economic growth, urbanisation and increased demand for water from agriculture, industry, energy supply and domestic sector. These drivers have benefited social and economic development, such as poverty reduction, job creation, food security enhancement, hunger and malnutrition elimination and rural development. However, they also influenced the water cycle and placed pressures on the water environment, water resources and associated ecosystems. The pressures and the resulted changes in the state of the environment include: human-induced climate change, water pollution, land use change and land degradation. These changes further affect the hydrological cycle by changing the quantity and quality of water resources which results in the changes of water availability and an increase in water-related disasters. Reduced water availability, together with increased water demand, will intensify water stress. Increased water stress can worsen the water competition among the users, induce water conflicts including upstream-downstream conflicts and damage ecological integrity. Furthermore, intensified water stress will impact on environmental water use and water requirements for maintaining the ecological integrity of the river basin, causing hydrological debt and long-term detriment of human development (UNDP, 2016).

The negative effects on the environment will entail harmful social and economic impacts. These include: adverse impacts on agricultural and industrial productivity, economic losses, food insecurity, disproportionate impacts on the poor by depriving access to safe drinking water and sanitation, impacts on health and well-being, increased malnutrition, enlarged inequalities and gender inequality. Responses include management approaches, mainly through integrated water resource management, and engineering solutions such as development of water infrastructure and improvement in relevant services.

For the LRB, the flourishing cage aquaculture in the midstream reservoirs before 2019 brought economic benefits to the local people and local governments and contributed to poverty reduction. However, intensive utilization of aquaculture without proper management can generate large amounts of manure and cause serious water pollution from pollutants such as suspended solids, , nitrogen and phosphorus, which can lead to oxygen depletion. Water quality degradation can compromise the supply of safe water to downstream Tianjin City, a metropolitan city with more than 15 million people relying on water mainly from the midstream reservoirs. To address this urgent issue, the Central Government issued a ban on cage fish farming in Panjiakou Reservoir which was implemented in early 2019 to force the removal of all the cages within a couple of months. The aim of the ban was to protect the water environment and ensure access to safe drinking water in the downstream cities. However, suddenly stopping local economic activity in the midstream has affected the livelihoods of aquaculture farmers, usually individuals or small holders, and led to population displacement and other consequences. The actual case in Panjiakou reservoir demonstrates the importance of taking account of synergies and trade-offs in river basin management and development and the significance of integrated water resource management through balancing the three dimensions of sustainable development and the developmental needs of the areas upstream and downstream.

Reflections on undertaking analysis at the sub-national scale

Our study has indicated that local context is important as environmental, social and political factors vary and co-vary across the catchment. Accordingly, national policies may not necessarily serve the interests at the subnational level and may cause unforeseen trade-offs. Therefore, it is important to reconginise that sustainable tradeoffs will need to be considered so that specific needs within, and across regions, can be addressed to ensure that important provisioning services (such as food and water) are maintained.

The systematic inclusion of a diverse range of local and regional stakeholders in this study has been essential for better understanding how possible trade-offs between national/regional (top-down) requirements can be minimised with a view to maximising synergies with local needs and plans. Working with local stakeholders has helped the team to evaluate and validate the usability of project outputs (i.e. policy briefs, maps and guidance) to ensure that they are not only appropriate for adoption by the local stakeholders but also sustainable interventions in the long-term.

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Related SDG interactive tool: https://sdginterlinkages.iges.jp/luanhe/index.html