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Theme: Development

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Asia-Pacific Regional Process Report

Regional Process Commission

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Theme: Development

Water, Development, and the Nexus

Theme Leader: FAO Regional Office for Asia and the Pacific

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Stockholm Environment Institute (SEI) Asia

Contents

Abstract

The past three decades have witnessed unprecedented growth in most parts of Asia with substantial improvements for food security. However, many development investments have triggered trade-offs, which creates increasingly awareness of the water, food, and energy Nexus and its inherent cross-sector relationships. Applied research suggests that the future achievement of development goals depends on the improved management of the Nexus. This challenge unfolds into three main elements, an improved capacity to assess nexus interactions and sustaonability outcomes, the governance of the Nexus, and the design of effective incentives and policy instruments to navigate Nexus trade-offs. This paper describes case studies in the Mekong basin, Myanmar and India to address these three challenges. Case study results suggest that strategically investing in parallel in all three domains – assessment, governance, and policy instruments – is likely to ensure a steady improvement of our ability to manage water, food and energy trade-offs and realise more sustainable development outcomes.

1. Background

1.1. Asia's development gains

Thirty years ago, large parts of Asia were facing substantial development deficiencies while during the 1980s Japan and the so-called Tigers (Singapore, Hong Kong, Taiwan, and South Korea) already experienced unprecedented economic growth. Over the past two decades, most of Asia's economies have experienced substantial growth, particularly China and Southeast Asia, with many countries graduating from least developed status, see Figure 1.

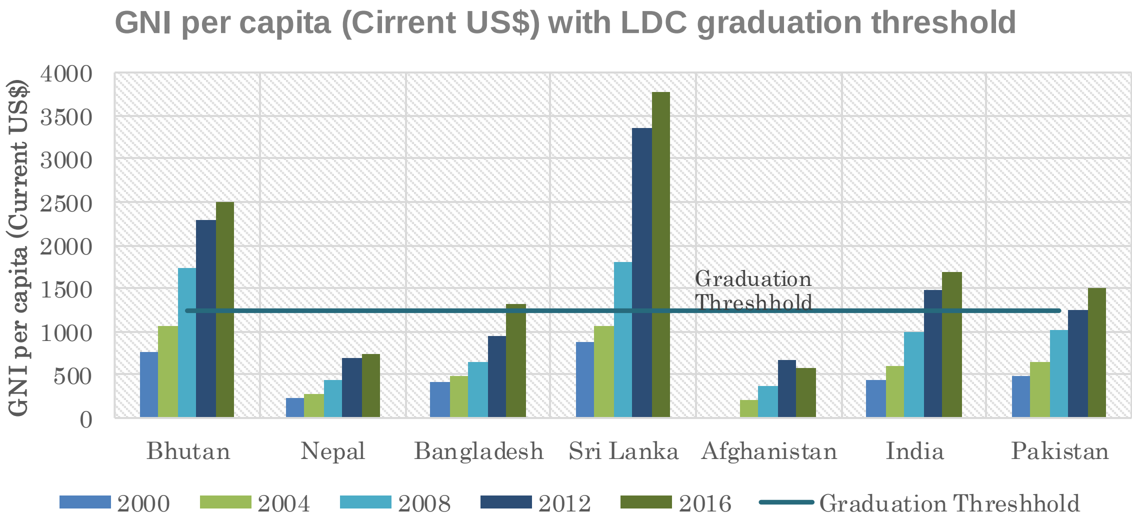

FIGURE 1 WORLD BANK DATABANK (COUNTRIES WITH MOST COMPLETE DATABASE)

The Gross Domestic Product (GDP) in South Asia increased from $443 per capita in the year 2000 nearly quadrupled to $1,640 in 2016, while in East Asia and the Pacific (excl. high income countries) GDP increased in the same period from $958 to $6,586 per capita, see Figure 2.

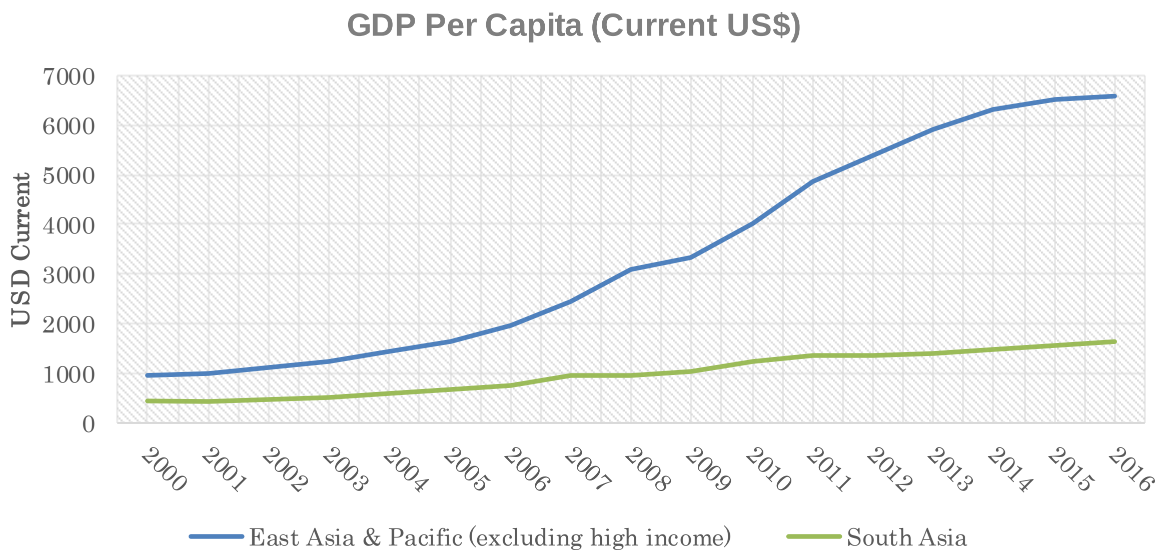

FIGURE 2 WORLD BANK DATABANK

This economic growth facilitated a substantial drop in poverty in South Asia from about 40% of the population in 2000 to 15% in 2013 and in East Asia and the Pacific from around 33% in 2000 to 7% (2013). With significant case studies in Kazakhstan and Indonesia. In Kazakhstan poverty rates decreased by at least 90% in rural and urban areas and in Indonesia, poverty decreased by 32% in rural areas and 42% in urban areas.

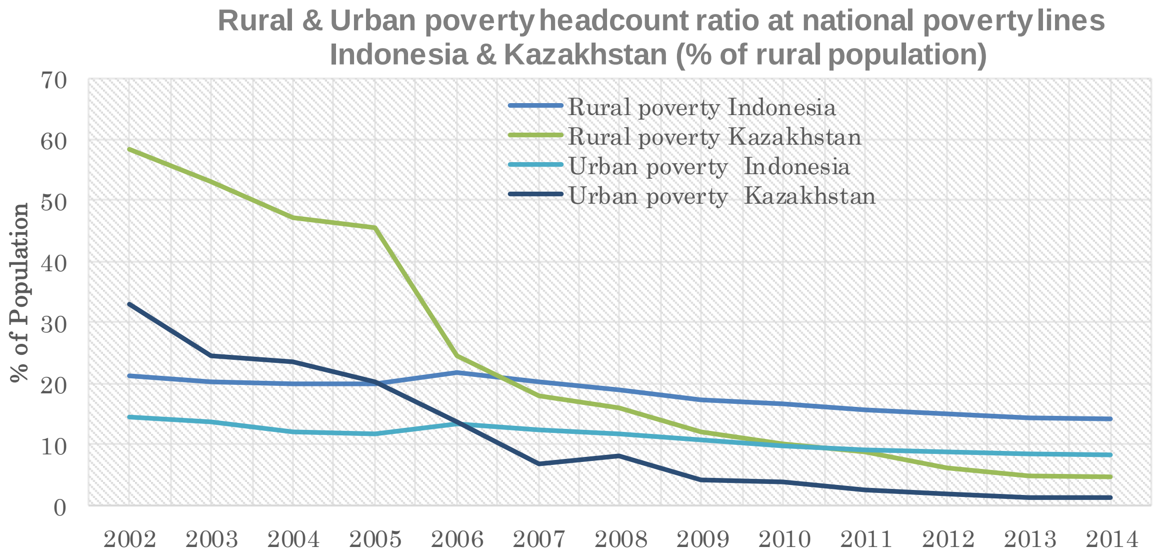

FIGURE 3 WORLD BANK DATABANK

According to the 2015 FAO report on the state of food insecurity in the world, much of this success is based on efficiency gains in the agricultural sector and the provision of energy access for the transition from primary to secondary and tertiary sector employment. Today in the Asia Pacific region, urban electrification rates are high, however this is still more work required for rural energy access.

ELECTRICITY ACCESS IN DEVELOPING ASIA - 2016				
Region	Population without electricity millions	National electrification rate %	Urban electrification rate %	Rural electrification rate %
China	**0**	**100%**	**100%**	**100%**
India	**244**	**81%**	**96%**	**74%**
Southeast Asia	**102**	**84%**	**94%**	**74%**
Brunei	*0*	*100%*	*100%*	*99%*
Cambodia	*10*	*34%*	*97%*	*18%*
Indonesia	*41*	*84%*	*96%*	*71%*
Laos	*1*	*87%*	*97%*	*82%*
Malaysia	*0*	*100%*	*100%*	*99%*
Myanmar	*36*	*32%*	*59%*	*18%*
Philippines	*11*	*89%*	*94%*	*85%*
Singapore	*0*	*100%*	*100%*	*100%*
Thailand	*1*	*99%*	*100%*	*98%*
Vietnam	*2*	*98%*	*100%*	*97%*
Rest of developing Asia	**166**	**66%**	**84%**	**56%**
Bangladesh	*60*	*62%*	*84%*	*51%*
DPR Korea	*18*	*26%*	*36%*	*11%*
Mongolia	*0*	*90%*	*98%*	*73%*
Nepal	*7*	*76%*	*97%*	*72%*
Pakistan	*51*	*73%*	*90%*	*61%*
Sri Lanka	*0*	*99%*	*100%*	*98%*
Other Asia	*29*	*35%*	*66%*	*24%*
Developing Asia	**512**	**86%**	**96%**	**79%**

TABLE 1 IEA, WORLD ENERGY OUTLOOK 2016

1.2. Development Gains and the Water, Energy, and Food Nexus

Asia's agricultural production increased by 52% between 2000 and 2016, this is largely due to substantial investments in irrigation improving food security (FAO 2015). As a consequence of increasing agricultural production, household income also increased, resulting in a drop in undernourishment from 17.6% (2000) of the population to 12.1% (2016). However, progress has been made with significant variances between Asia's sub regions (FAO 2015). Major gains were made in South East Asia with a reduction in undernourishment by 53%, in Central Asia 47%, and in East Asia by 37%, however major challenges maintain to bottleneck progress in South Asia, while with still a significant 18% reduction, there is still much more work to be done to ensure consistent reductions in undernourishment.

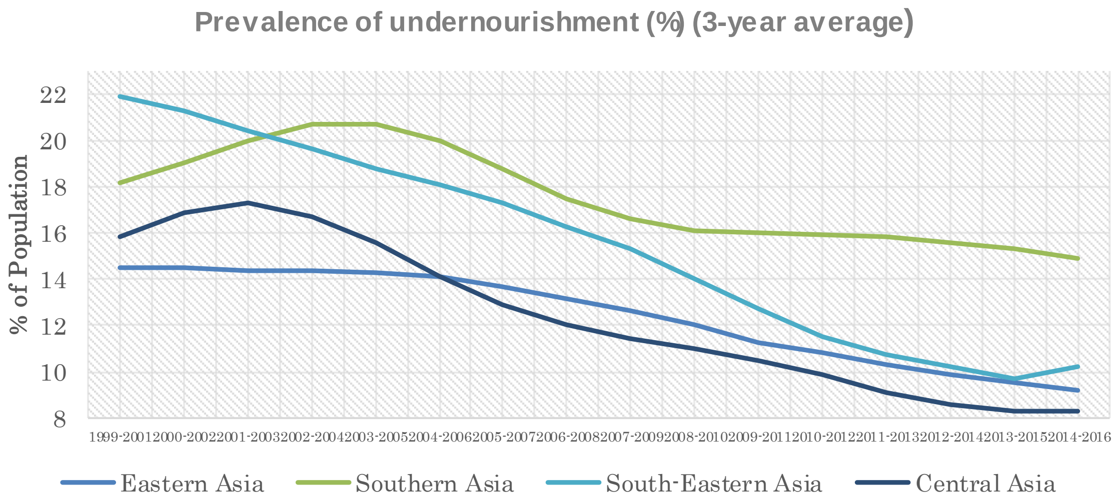

FIGURE 4 FAOSTAT

The rapid changes in the Southern and Eastern parts of Asia constitutes a profound improvement in food security in the region. "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO 2003). The success in reducing hunger cannot deflect from the fact that still over half a billion people in Asia suffer of undernourishment and hunger. Considering the commitment to the elimination of hunger and malnutrition by 2030 in the Sustainable Development Goals (SGDs) the challenge remains high.

Key factors contributing to food insecurity include:

- Loss of fisheries, largely due to overfishing and the construction of dams and other barriers for fish migration;
- Loss of arable land, largely due to urbanization;
- Loss of land under food production, largely due to the rise of energy crops and other cash crops;
- Increasing competition for water, largely due to urbanization and industrial water uses; and
- Loss of soil fertility combined with increasing fertilizer prices.

Placing food security into the context of these drivers highlights the relevance of water, food and energy nexus interactions. Changes in water management can affect the availability of water for irrigation. Power generation investments can affect water demands (e.g. cooling) and water availability for irrigated agriculture, but can also affect fish population (e.g. hydropower) and the availability of land for food production (e.g. energy crops). Energy prices can affect the (economic) efficiency of pumps for groundwater and surface water based irrigation, and also affect the competitiveness of food crops against energy crops.

Concurrently, some core development drivers impact on all three sectors at the same time, including, for instance urbanisation dynamics and lifestyle changes.

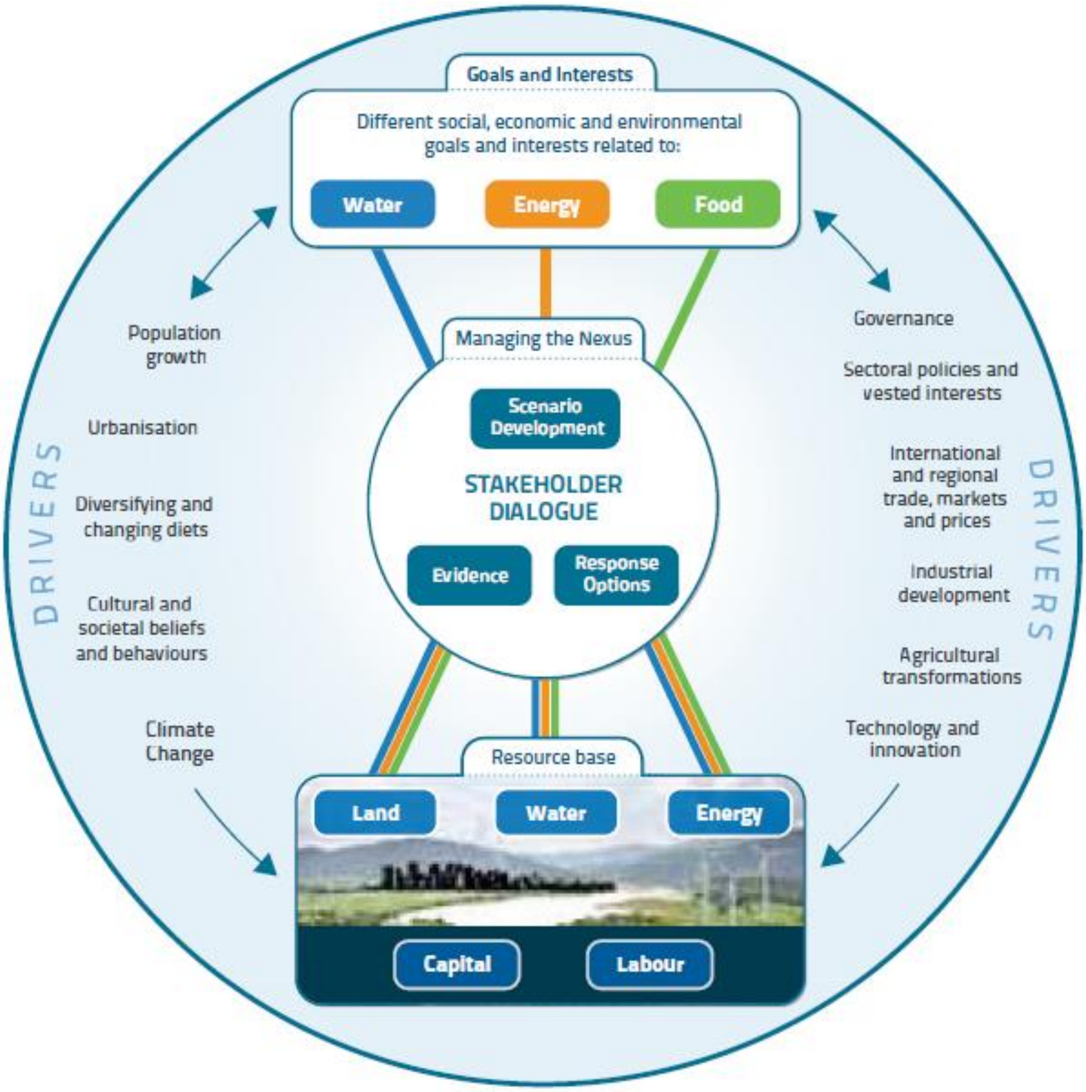

FIGURE 5 NEXUS APPROACH (FAO)

The Nexus paradigm has been promoted to manage interactions between the water, food, and energy sector to avoid trade-offs and facilitate synergies. Such a Nexus approach aims to replace traditional sector optimisation, which is 'silo-ised' and risks sub-optimal societal outcomes. Thereby, Nexus assessments identify combinations of sector investments that lead to improvements at the wider societal scale.

The challenge is to find strategies for managing the water, energy and food Nexus. While the science community developed a variety of Nexus conceptualisations there is a need to implement and analyse empirical Nexus assessments. Furthermore, cross-sector coordinating government agencies (e.g. Ministry of Planning and Investment, Ministry of Finance) and its community of supporting practitioners require practical tools or instruments that help managing the impending trade-offs and synergies. Conventionally, a successful first step is to compare case study results to derive possible trajectories and, thereby, determine effective heuristics (or guidelines) for policy makers. Such heuristics should enable cross-sector coordinating agencies to (a) safeguard critical levels of food security, water security, and energy security, (b) expand these important sectors to facilitate growth across the wider economy and, thereby reduce poverty and improve wellbeing, and (c) design investments so that sustainable outcomes can emerge from Nexus interactions.

The objective of this paper is to assess a few case studies to identify Nexus relationships that are critical for understanding food security dynamics. Ultimately, this assessment aims to deliver towards the longer agenda of developing practical guidelines for Nexus management.

This comparative assessment approach employs case studies from Myanmar, the lower Mekong basin and India's ground water realities. Key messages include that

- The sustainability of development outcomes depends on the ability to manage cross-sector trade-offs resulting from interactions in the water, energy and food Nexus;
- Assessment methodology and underpinning data (incl. water accounting) requires improvement and context-specific implementation;
- Governance systems have the existing cross-sector coordination mechanisms that can be improved to improve Nexus interactions;
- Existing policy instruments need to be re-assessed against their Nexus-wide impacts and new incentives need to be designed to improve development outcomes.

2. Case studies: Lessons learnt from Nexus studies in Asia

2.1. Myanmar

The notion of an integrated water-energy-food (WEF) sector 'nexus' governance framework is an attractive proposition in Myanmar, a least developed country (LDC) that has recently emerged from economic isolation. Myanmar faces significant development challenges on many social, economic and environmental fronts, both within and outside of the WEF sectors. One such challenge is that less than one-third of the nation's 54 million people have access to electricity, and achieving 100% national electrification by 2030 is a central policy goal (ADB, 2012).

The emergence of the nexus approach, and many subsequent 'applications', focus largely on developed country contexts with well-established policy frameworks and institutional arrangements. The aim of this case study is to assess whether adopting a nexus approach would enhance the governance of water, energy and food in Myanmar, and advance efforts to achieve national policy goals. The results and recommendations draw upon interviews conducted in 2016 with Myanmar's national level policy-makers in sectors within and outside of the WEF sectors, to understand sectoral priorities, governance arrangements, and coordination mechanisms.

In Myanmar, national level modes of collaboration are largely dependent on two main factors:

- **Policy issues:** Inter-sectoral points of collaboration for most sectoral ministries are around policy specific issues (i.e. resettlement, disaster warning and response, increasing farm income, irrigation canal improvement and food security).
- **Mainstreaming:** The Environmental Conservation Department (ECD) under the Ministry of Environmental Conservation and Natural Resources (MONREC) and the Public Health and Occupational Safety Department under the Ministry of Health (MOH) emerge as central players in interactions amongst ministries as their mandate is to mainstream environmental protocols and health safety regulations amongst all ministries.

Water governance in Myanmar is fragmented and governed in disparate components rather than as a system. One reason for this fragmentation is because jurisdictional boundaries for governance are clearly defined within their agency mandates. For instance, the Department of Electric Power Planning (DEPP) responsible for large dams and waterways has jurisdiction of waterways within five miles upstream and downstream of their dams yet, beyond five miles, jurisdiction falls under the Directorate of Water Resources and Improvement of River Systems (DWIR). However, this is expected to change as the DWIR, despite its primary mandate to improve river navigation has been given additional responsibilities to conserve water resources.

Sectoral collaboration and integration is broadly regarded as positive, and institutional integration has been on-going at different levels since the current administration took office, though integration not exclusively aligned the WEF sectors:

- **Ministerial level:** Ministry of Environmental Conservation and Forestry (MOECAF) now merged with the Ministry of Mines (MOM) to form the Ministry of Natural Resources and Environmental Conservation (MONREC)
- **Departmental level:** Water Resources Utilization Department merged with the Irrigation Department forming the Irrigation and Water Utilization and Management Department
- Further, donors emerge as key facilitators of collaboration on natural resource and economic development policy priorities, particularly The World Bank, Asian Development Bank, and the Japanese International Cooperation Agency.

It was found in Myanmar that it is not entirely clear that studies implementing a nexus approach can enhance understanding of pressing problems in developing countries in a policy relevant manner, while not addressing issues pertaining to livelihoods and a broader array of inputs and natural resources. Further, policy issues, mainstreaming and agency mandates may bring actors together to improve governance in Myanmar rather than the WEF approach. However, there is currently substantive ccollaboration and integration to improve governance in Myanmar as the country reforms which has created clear mandates and roles to allow ministries to carry out their work coherent. It is seen that clear rules could also enhance collaboration. E.g. DWIR could become a powerful central water institution because of the new mandate.

While there are strong, existing sectoral and inter-sectoral connections amongst ministries. SEI's study concluded that rather than striving to create new links to enhance integration and collaboration, policy efforts can build off existing links. Further, donors could emerge as central actors in policy issues and can play a coordinating role in strengthening these connections to improve governance. Development efforts such as capacity building and funding could be geared towards improving these networks. Lastly, institutional structure in Myanmar is in flux. Clear roles, goals and mandates (not overlapping) amongst ministries need to be established before recommending which sectors are to integrate.

2.2. Lower Mekong basin

The Mekong basin is experiencing a phase with substantial influx of investments, largely driven by the private sector, which facilitated a previously unexperienced increase in economic growth. Given the sectoral focus of many of these development trajectories important vulnerabilities have shifted. In order to understand these shifts the Mekong Region Futures Institute (MERFI) applied the Nexus perspective in the lower Mekong basin. The most significant Nexus relationship connects hydropower, fish, and irrigated agriculture. Mekong basin countries strive for further economic development and policy makers aim to reduce energy constraints to facilitate growth of secondary and tertiary sectors. The Mekong provides substantial hydropower potential, which has already been realised in the upper basin, the Lancang in China. Now hydropower is being increasingly realised by Lao PDR. The effect on food security is projected to be substantial as the combination of barrier effect, flow changes, and nutrient reductions is impacting on fish stocks and, thereby eroding a critical source of protein. Concurrently, irrigation expansions hold the potential to increase food security. However, due to current market conditions energy crops are more competitive than food crops and were therefore able to increase their percentage in land use continuously over the past decade, in particular cassava and sugarcane. Other cash crops contribute to the pressure on food security, in particular rubber plantations. This translates into improved energy and water security but at the cost of declining food security.
The case study combined three hydrological models, a whole of basin model, a high-resolution model for the Tonle Sap area and a flood plain model for the Mekong Delta. Additionally, an agent-based model was developed to simulate land use change, spatial poverty shifts, livelihoods adaptation processes, and migration. The agent-based model was parameterised by a large-scale household survey and several GIS layers to visualise changes in a dynamic map. The case study, and its methodology, process and results are described in detail in Smajgl et al. (2015) and Smajgl and Ward (2013).

The scientific analysis was embedded in a participatory process to ensure assessment remains focused on actual policy needs and to make the policy uptake more likely. Participants included senior staff from national line ministries and international donor organisations.
An important lesson learnt during this process was to emphasise the importance of the design of the engagement process, particularly in the context of multiple sectors (ministries) and the transboundary context of the lower Mekong basin. Compared to other science driven processes this policy driven process had substantially more influence on planning decisions. The potentially most critical part was the development of a vision all sectors and countries shared. It facilitated a solution focused discussion, which acknowledged cross-sector

trade-offs. A second lesson learnt is that the participatory approach can create challenges for the research team as it requires more flexibility than the traditional research approach typically requires. An additional 'internal' challenge emerged with the transdisciplinary approach any Nexus assessment requires; team members from different disciplines had to understand each other better to effectively investigate the cross-sector linkages. Hence, for an empirical Nexus assessment scientists need to apply a systems approach and need to be provided with sufficient resources to ensure effective communication.

2.3. Indian groundwater

Over the past decades, food security concerns have guided large investments in India's rural planning. The uneven and uncertain distribution of rainfall many states experience constitutes a major risk for crop failures. Ghosh et al. (2012) emphasises that investments in irrigation infrastructure is a key strategy to alleviate rural poverty and ensuring food security. While top-down investments established reservoir capacity to mitigate climate risks bottom-up adaptation was largely energy driven. Over the past decade, the availability of cheap pumps and increasingly reduced energy costs groundwater pumping has emerged as a major adaptation strategy at the farm level. In Rajasthan and Gujarat aquifers are characterised by limited porosity and connectivity, which delays the refilling of natural groundwater storage. This link between food, water and energy has introduced an additional, long-term vulnerability if not managed sustainably.

The MARVI program (Maheshwari et al., 2014) conducted an assessment of spatial and temporal dynamics of groundwater aquifers in regards to water quantity and quality. This hydrological information was then connected to farmers' behaviour and underpinning incentives to develop a governance and monitoring approach that helps realising a more sustainable utilisation of groundwater in Rajasthan and Gujarat. This case study combined hydrological modelling and sampling with household surveys and workshops. The workshops involved farmers and focused on awareness raising, monitoring options, and on the design of effective village level institutions (or rules-in-use).

One of the main challenges in this context is the design of effective institutions as some state level legislation assigns ownership to land holders (connecting property rights of water to land titles) while the Government of India assigns water rights to states. Considering the complexity of groundwater related dynamics this case study aimed to design a village-level governance scheme that introduces effective constraints and shifts current incentives of groundwater users. Monitoring emerged as a central challenge considering the level of utilisation of groundwater pumps.

The participatory design of this study, which involved stakeholders from multiple levels (village to state) identified the relevance of local champions to take the promising designs to the next step of implementation. Currently, the results are being considered for upscaling across four states based on funding provided by the Government of India and the World Bank.

3. Action towards sustainable Nexus interactions

FAO's position paper for the 7th World Water Forum (Facon and Wojciechowska 2015) lists six key results areas (KRAs) for achieving improved food security outcomes for Asian communities and for integrating food security better into a wider Nexus perspective:

1. Implementing sound and innovative water accounting and auditing to support decision- making and management
2. Evolving risk management strategies for national food security policies under water constraints and economic transitions
3. Implications for agricultural and rural water management of a renewed focus on ensuring farmer and rural prosperity for managing socio-economic transitions sustainably: plotting new futures for irrigation and drainage under long-term vision
4. Supporting investments boosting ecosystem and water productivity, maintaining water quality across agriculture, fisheries, aquaculture, irrigation and drainage-recognizing its multiple services- and their supply chains and supporting rural transformations:
5. Managing the changing dynamics of the water- energy-food nexus
6. Capacity building

3.1. Water Accounting

As water scarcity is a key issue of the water, energy and food Nexus, pressure on agriculture water use to become more 'efficient' is increasing, but water conservation policies, strategies and investments are often founded on a misunderstanding. Productivity and efficiency gains do not necessarily mean that more production will be possible with less water. Additionally, effective and accurate monitoring is lacking in order to understand sectoral water use intensities over time. Across Asia, many initiatives have started designing or implementing improved monitoring schemes to effectively account for the various water uses at the river basin and improve efficiency. Increasing efficiency in this context means that consumption is increased as the service more precisely and uniformly matches water needs.

3.2. Infrastructure Investments

The management of food security risks due to climatic or economic drivers requires more innovative solutions, particularly when water related incentives shift between food and energy. Recent droughts and floods across the region have emphasised the need to put effective infrastructure in place to mitigate food insecurity. Most attention received infrastructure solutions in form of more reservoirs to reduce peak related effects. Further, in order to address climate variables which have seen to have a significant impact on

physical/human capital – such as roads, storage and marketing infrastructure, houses, productive assets, electricity grids, and human health – which indirectly changes the economic and socio-political factors that govern food access and utilization and can threaten the stability of food systems (FAO 2008). Clearly, improved development and higher income have enabled most Asian countries to provide more effective responses in extreme situations and avoid widespread famine however as the climate continues to change, our solutions will need to evolve.
Currently the Asian Development Bank is implementing innovative approaches in Tajikistan to improving food productivity and distribution such as agribusiness value chain development, knowledge development for farmers on external markets and cultivating techniques, as well as rehabilitated and constructed climate-resilient irrigation channels, river embankments, and rural water supply schemes to assist countries in tackling their infrastructure deficit to ensure food security.

Further, economic influences can unfold in annual trends or in form of long term trends. Annual fluctuation in the price of rice and other food crops can trigger substantial problems for those households that have no subsistence production, particularly the urban poor. These economic processes have also converted into trends that affect food security incrementally. For instance, the growing difference between economic margins farmers generate from the production of rice and from energy crops (e.g. sugarcane or cassava) converts into an increasing share of energy crops in agricultural production. Depending on population growth and productivity improvements these shifts can lead to a reduction in food production per capita. For instance, in 2006, total world production of cassava was around 226 million tonnes with Africa as the main producer region, with Nigeria, Brazil, Thailand, Indonesia, and the Democratic Republic of Congo accounting for almost 70 percent of the world´s cassava (FAO, 2000). Cassava is also used as starch for myriad food products and industrial goods, including cardboard, glue, laundry starch, textile, plywood, tapioca pudding, and alcohol (FAO, 2000; FAO, 2002). The second important use of cassava is as a feed ingredient for pork, poultry, cattle and fish farming. A number of projects have been designed to increase the production and industrialization of cassava for income generation and food security for the low-income population in rural Africa and Asia (FAO, 2001; Manyong et al., 2000). Since this crop is important for food, feed, and the livelihood of people in the developing countries, there has been concern about the impact of its use for biofuel feedstock on food security (Sidhu, 2011). In terms of international trade, Thailand supplies around 80 percent of cassava on the world market (FAO, 2001). Thailand, Viet Nam, Nigeria and especially China are among the countries that are considering using cassava for bioethanol. Realizing that using food crops for biofuel can contribute to increases in food prices, from 2007 onwards the Chinese government stopped new plans for grain based ethanol, and looked as alternatives at cassava and sweet sorghum, considered in China as non-food crops (Huang et al., 2008). China´s increased imports for cassava especially from Thailand, as biofuel feedstock instead of wheat and corn, contributed to the increase in the price of cassava in 2008 (Rosenthal, 2011; Scott & Junyang, 2012; Fengxia, 2007). Raw cassava exports from Thailand, the world's largest exporter, switched from EU for feed to China for biofuel: Thailand sent nearly 98 percent of its cassava pellets exports to China in 2010, a fourfold increase over 2008 (Rosenthal, 2011; Sidhu, 2011).[1]

3.3. Irrigation Investments

The need to have long-term visions and strategies in place that improve farmers' livelihoods remains a critical action for sustainable development in rural areas. Adequate investments in irrigation and drainage are pivotal to a sustainable Nexus and resilient food production systems. Many investments across Asia have focused on these investment needs. For instance, the Huang-Huai-Hai Plain is critical to China's agricultural economy and national food security. Productivity is threatened by climate changes, including a significant overall increase in temperature and declining levels of humidity and precipitation over the past half-century (Yang et al., 2015; Hijioka et al., 2014). In five of the region's provinces, a World Bank financed project has promoted water-saving technologies and other improved practices – such as the use of drought-resistant crop varieties – with the goal of improving water management on some 500 000 ha of farmland. Irrigation facilities constructed as part of the project were transferred to 1 000 water users' associations, which were formed with government support and participate in all water management decisions. The associations also provide platforms for training in new water management techniques. The project helped establish 220 farmer associations and cooperatives and undertook a variety of research, experimental and demonstration activities. The focus was on adaptation measures and water-saving technologies, which were subsequently put into practice by farmers. Some 1.3 million farm families saw benefits in the form of reduced irrigation costs, less groundwater depletion and higher water productivity.[2]

3.4. Ecosystem Management

The management of agricultural areas as an integral part of the surrounding ecosystems is still rarely acknowledges as the majority is focused on infrastructure based production improvements. The expansion of agricultural area at the cost of important wetlands or forests is still common and ecosystem services and their (economic) value for agriculture, for the supply chain, and the broader society are still rarely integrated in the decision-making process. For instance, the ADB and the Global Environment Facility have developed a program to ensure food security in five Pacific Coral Triangle Initiative countries (Fiji, Papua New Guinea [PNG], Solomon Islands, Vanuatu, and Timor-Leste) by addressing the need to increase the resilience of coastal and marine ecosystems. It will support the introduction of more effective management of coastal and marine resources to build their resilience in a period of increased threats arising from human activities and climate change impacts. The technical assistance will

[1] http://www.fao.org/fileadmin/user_upload/hlpe/hlpe_documents/HLPE_Reports/HLPE-Report-5_Biofuels_and_food_security.pdf
[2] http://www.fao.org/3/a-i6030e.pdf

contribute toward halting or reversing the expected decline in ecosystem productivity caused by these stressors through more effective management that addresses land and water interactions and the management of threats to coastal habitats arising from local human activities. By maintaining productivity over a longer time frame, local community well-being will be ensured.[3]

3.5. Energy Technologies

FAO has recently launched a technical cooperation project with Pakistan and Bangladesh to assess the relationships and risks of solar powered irrigation and water scarcity. In recent years, solar powered irrigation systems (SPIS) have become increasingly viable for countries as a reliable, clean-energy solution for agricultural water use, especially in areas with high-incident solar radiation. Further, a growing number of countries are promoting SPIS in the framework of national action plans against climate change as a way of reducing carbon emissions in agriculture.

However, the conditions for SPIS vary from country to country, including biophysical and climatic suitability, techno-economic feasibility, institutional arrangements, regulations and policy support, financing and economic viability. Recognising the specific context in each country, FAO is seeking to explore how the promise of SPIS can be realised, whilst openly addressing the risks and challenges that come with the technology – keeping in mind the relationships that exist within the nexus. Within the project, however, FAO is going further to also explore the equity issues between groundwater resources and energy transformations. When considering the Nexus in these contexts, it is necessary to turn attention to better understanding how a technology, or energy transformation for the better can also effect natural resources.

3.6. Capacity Development

At the core of many of these development processes is capacity building, which is a prerequisite for sustainable development. This covers several of the domains addressed in this paper, including the analytical capacity to conduct impact assessments and the evaluation and design of governance mechanisms and policy instruments most suitable for the country-specific context. Recent years have seen a substantial surge in capacity building programs carried out in most Asian countries. For instance, the agrarian sector in Central Asia undergoes radical transformations, involving restructuring of agriculture, transfer from large state and collective farms to smaller private or leased farms. New masters of farm, who had money, needed skills and recommendations for efficient crop production and development of multiple agrarian branches. To address the knowledge gap of farmers who must contend with complex changing dynamics (ie: climate, market access, price volatility, etc.) this initiative seeks to establish a system for transferring knowledge and best practices, including scientific developments, to farmers and their organizations in order to ensure growth of productivity and risk management in agriculture. The system will permit to increase sharply efficiency of farmer's production by merging their land and financial capacity and scientifically based technology, recommendations and methods. 'Extension services' are being developed

[3] https://www.adb.org/sites/default/files/publication/29078/climate-change-food-security.pdf

(production of manuals & guides, guidelines, online forecasting tools), along with 'Provincial information Centres', with support from research centres and universities who provide zonal recommendations and proposals.

4. Conclusion

Empirical evidence emphasises the relevance of trade-offs between investments in the water, food and energy sectors. Managing these trade-offs is a key challenge for achieving sustainable development outcomes in Asia and beyond. Neglecting these trade-offs is likely to diminish the development potential of many investment opportunities or create even negative development outcomes.

Recent case studies have shown that three domains need to be further improved to enhance our ability to avoid cross-sector trade-offs and realise synergies. One domain is concerned with the assessment and analysis of development projects. This assessment domain needs to be advanced to improve the understanding trade-offs in particular contexts, which requires improved integrated assessment methodology that allows for integrating water, food and energy interactions. This is likely to establish further data requirements. Such advancements need to be supported by an improved policy-science interaction that contributes to effective evidence-based decision making.

The second domain relates to the governance system, which needs to account for water, food, and energy trade-offs. Case studies have shown that improved cross-sector planning and coordination is partly possible within existing structures. In some instances, it might benefit from additional inter-agency planning processes that focus on cross-sector effects and provides the platform for negotiating sustainable outcomes. It seems pertinent to consider the water, energy and food Nexus when implementing changes to the governance system to further improve cross-sector coordination.

Third, policy instruments or incentives are often defined to optimise single sector outcomes while creating substantial losses in other sectors. These incentives include prices, taxes and subsidies, and access rights. For instance, energy subsidies in India help realising energy specific goals but result in unsustainable levels of groundwater use. Similarly, market incentives that make hydropower investments highly profitable affect fish, the main protein source for millions of households in the lower Mekong basin. Identifying the side-effects and adjusting incentives accordingly is a critical step in managing Nexus trade-offs.

So far, many unsustainable outcomes have emerged as unexpected and unintended side effects from sector-focused investments. Strategically investing in parallel in all three domains – assessment, governance, and policy instruments – will ensure a steady improvement of our ability to manage water, food and energy trade-offs and realise more sustainable development outcomes. Water accounting is an important activity supporting all three of these domains.

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