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WATER-ENERGY-FOOD NEXUS
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# Proceedings of the South Asia Regional Fulbright Alumni Workshop on the Water-Energy-Food Nexus 2015

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# Proceedings of the South Asia Regional Fulbright Alumni Workshop on the Water-Energy-Food Nexus 2015

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# Acronyms

| | |
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| FUG | forest user group |
| ICIMOD | International Centre for Integrated Mountain Development |
| IRSA | Indus River System Authority |
| NWCF | Nepal Water Conservation Foundation |
| WEC | Water and Energy Commission |
| WEF | water, energy, and food |

# Introduction

South Asia's water crisis is a worldwide concern. The region's population is soon expected to reach two billion; the greater Ganges Basin alone is home to 700 million people, many of whom are among the poorest in the world. Recognizing that managing water resources in this region to alleviate poverty has historically been an intractable problem and that any hope for solutions requires a multidisciplinary approach, the Nepal Fulbright Commission and the United States Embassy in Nepal hosted a workshop in 2015, in collaboration with the International Centre for Integrated Mountain Development (ICIMOD), the Nepal Water Conservation Foundation (NWCF), and the World Bank. The workshop aimed to foster an interdisciplinary and transboundary discussion of the interrelationships among water, energy, and food (WEF).

While policy makers are keenly aware of the challenges associated with water, energy, and food resources as separate concerns, such issues have traditionally been considered without sufficient regard to their interdependence. However, the United Nations World Water Development Report 2014 points out that water, energy, and food are inextricably linked. Water is vital for agriculture and an important source of renewable (hydropower) energy in the region. Yet energy is required to produce and distribute water and food including to pump groundwater and surface water, power agricultural machinery, and transport agricultural goods. Globally, agriculture is the largest user of water, using 70% of total ground and surface water withdrawals, and the food production and supply chain accounts for about 30% of total global energy consumption. There are many synergies and trade-offs among water

*Paddy plantation*

and energy use and food production; for example, using water to irrigate crops may promote food production, but it can also reduce river flows; growing bio-energy crops with irrigation can increase water use, which may threaten food security; and converting surface irrigation into high-efficiency pressurized irrigation may save water, but it can also increase energy use. We need to recognize these synergies and balance these trade-offs to ensure water, energy, and food security in South Asia and the world (World Water Assessment Programme, United Nations and UN-Water 2014).

To explore some of these synergies and trade-offs, the South Asia Regional Fulbright Alumni Workshop on the Water-Energy-Food Nexus convened in Kathmandu from 10–12 February 2015. The workshop assembled 60 South Asian alumni of the Fulbright, Humphrey, and International Visitors Leadership programmes, along with 40 regional and international experts, to promote a shared understanding of water, energy, and food issues in the region. Experts in water resources, as well as those specializing in food and energy security, brought to the workshop many years of experience in their own fields and countries. Participants and speakers included government officials, academics, researchers from think tanks, representatives of non-governmental organizations, and activists. The goal of the three day workshop was to promote a shared understanding of the complex interrelationships among water, energy, and food issues in South Asia and beyond.

The first day, coordinated by the World Bank, considered the physical dimensions of the nexus. The second day, coordinated by ICIMOD, considered the social dimensions of the nexus. And the third day, coordinated by NWCF, considered the institutional dimensions of the nexus. Each day began with a keynote address, followed by moderated panel discussions, question and answer sessions, interactive group activities, as well as plenary sessions. The workshop was organized around three main lenses through which to view the water-energy-food nexus: physical, social, and institutional.

Keynote speakers included Professor Christopher Scott (USA), Dr Aditi Mukherji (ICIMOD), and Dipak Gyawali (NWCF). Special remarks were presented by the United States Ambassador to Nepal Peter W Bodde and journalist Cheryl Colopy, also from the USA. Presentations were made by Dr Nagaraj Rao Harshdeep (World Bank), Dr Ethan Yang (World Bank), and Dr Bill Young (World Bank). Activities were facilitated by Dr Anjal Prakash (ICIMOD) and Dr Philippus Wester (ICIMOD). Panellists included Mir Sajjad Hussain (Bangladesh), Nisar Memon (Pakistan), Mr Bihari Krishna Shrestha (Nepal), Dr Dwarika Nath Dhungel (Nepal), Ms Kusum Athukorala (Sri Lanka), Dr Dinesh Kumar (India), Mr Shakil Ahmed Ramay (Pakistan), Professor Jiang Tong (China), and Dr Ravinder Kaur (India). On the final day of the workshop, the United States Deputy Assistant Secretary of State, Fatema Z Sumar delivered a special address.

As several speakers reminded attendees during the workshop, South Asia – despite its great rivers – is one of the world's most water-stressed regions. Per capita water availability has fallen by 70% since 1950. South Asia's population is growing by 25 million per year and the region has the world's highest population density. Standards of living and demand for clean water are increasing. Rising water demand is coinciding with dropping groundwater tables and increasingly unpredictable hydrological cycles. South Asia depends on the monsoon, the world's highest seasonal concentration of rainfall and among the most unpredictable. This makes the region particularly vulnerable to droughts and floods – both of which are likely to be amplified by climate change. The vast ice mass that covers the Hindu Kush Himalayan mountain range, storing water and providing continuous river flows during the dry months, is also highly vulnerable to climate change.

According to some predictions, global demand for water could exceed availability by 40% by 2030; energy needs could increase by 50% by 2035; and agriculture may have to produce 70% more food by 2050. The sustainable use of South Asia's water resources requires strategies that can support the sustainable development of agriculture and hydropower, along with public and river health – which demands policy makers who can grasp the interrelations among water, energy, and food and apply that knowledge.

# Day 1. The Physical Lens

## Welcome remarks

Before the first keynote address, the workshop organizers highlighted the purpose and goals of the workshop and the importance of adopting integrated regional cooperation using the nexus approach. The Nepal Fulbright Commission Executive Director, Dr Laurie Vasily, noted that scarcity in any of the three resources under discussion – water, energy, or food – may cause a crisis. Forestalling such crises in South Asia requires a shared understanding of the use and misuse of resources. A workshop like this upholds the Fulbright Program's goal of fostering understanding among people in different countries to promote cooperation. Sharing knowledge and experience can ultimately feed into action and the implementation of equitable and sustainable policies.

Dr Bill Young, the World Bank's Lead Water Resources Specialist, noted that the twin goals of the World Bank – eliminating extreme poverty and boosting shared prosperity – lie at the core of the WEF nexus. South Asia is home to 40% of the world's poor, but is the least integrated region economically. He said that "There is growing recognition that efficient management of water resources must become an integral part of the solutions needed to end poverty and boost shared prosperity in South Asia". "The World Bank has increased its portfolio in hydropower and energy transmission grids", said Young, "and engaged in water resource management as well as analysis, capacity building, and dialogue". Disaster risk reduction has also emerged as a key area of engagement.

Dr David Molden, Director General of ICIMOD, noted that mountains and mountain people play a special role in the WEF nexus and in this region. Everyone knows that Nepal has massive hydropower potential, but this water, when it reaches downstream, also irrigates the farmlands of India and Bangladesh. Dr Molden urged participants, when trying to build connections across borders and countries, to keep the interests of mountain people in mind.

"Our current 'de-nexused' approaches have led to enormous avoidable waste," said Dipak Gyawali, Chair of the Nepal Water Conservation Foundation. Experts have estimated that the amount of food wasted between harvesting and the dining table averages is as high as 50% of production. By 2030, the demand for food, along with water and energy, is projected to increase by 30–50% globally, largely due to population increases and economic growth. The nexus idea entails opportunities as well as danger. The danger is that we might see 'old wine' or old practices repackaged in a 'new bottle'. However, Gyawali concluded, there is a chance that this new discourse can provide an opportunity for marginalized voices to be heard.

Journalist Cheryl Colopy highlighted the sophisticated and effective water management systems that have developed over the millennia throughout South Asia, and which served a smaller subcontinental population very well. She suggested that techniques employed in this traditional, indigenous water management system be revived to alleviate water shortages and suffering.

## Keynote address: *Dr Christopher Scott*

### University of Arizona

In the first keynote address of the three day workshop, Dr Christopher Scott of the University of Arizona outlined some of the advantages and disadvantages of employing the water-energy-food nexus to get a handle on solutions for South Asia. He said that only by exploring both the risks and rewards of using such a nexus for policy discussions and decisions can we devise good strategies. This workshop offers a way to advance such discussions.

*Dr Christopher Scott, University of Arizona*

Each component of the nexus is fundamental to human life and wellbeing. Understanding the connections among them can help promote efficiency in their use, greater equity in their distribution, and greater national security for the resource-stressed countries of South Asia. Irrigation is fundamental to food security and hydropower is fundamental to energy security in South Asia. Sustainable farms and cities require water security. Using the nexus can help define some of these interrelationships.

There are also forces outside of the nexus that influence all three components. Climate, and specifically climate change, will increasingly influence resources and decisions about managing them. Environmental quality is also fundamental; people need clean water to live and grow food. And governance, as the mechanism through which we pursue development goals, must be evaluated in formulating policy and managing resources.

Dr Scott cautioned that there are risks and trade-offs in WEF couplings. Gaining efficiency in one could lead to waste or inequity in another; e.g., when electricity becomes cheaper it is typically used more, which may have unintended consequences. The purpose of this workshop is to explore some of the risks and trade-offs of the nexus and to think about its social dimensions and politics. What fundamental efficiency gains are we looking for? How does energy and energy efficiency tie into food production and distribution?

Dr Scott noted a traditional bias toward seeing WEF nexus resources in terms of infrastructure (turbines and pumps). Agriculture is often forgotten in depictions of the nexus/hydrological cycle, but it has to be seen as central to such discussions.

Simply refining our understanding of complex, coupled social and ecological systems is not enough. Many urgent problems loom that threaten the wellbeing of those systems. We have reached a critical point and we face a choice. Do we follow our previous path of unsustainable resource extraction and exploitation? Do we continue to rely on economic models that promote accumulation and extraction at the expense of depletion, leading to ecosystem degradation throughout the world, and to people trapped in systems where their only survival option is to contribute to depletion and degradation? Or do we chart a new course that supports sustainability, ecosystem health, and equity?

Dr Scott noted a shift in global thinking towards sustainable futures and resilient ecosystems. He said that a change in direction has begun based on holistic systems thinking, which has generated a new understanding of the complex interconnected links in human and environmental interactions. Thus the idea of Sustainable Development Goals has begun to develop, in contrast to the Millennium Development Goals of recent decades. The WEF nexus can be a useful tool in pursuit of this new way of framing development goals.

Dr  Scott proposed looking at each of the three resources through the lens of the other two to begin to escape the prevailing silo mentality. For example, the view of food from a water perspective reveals that the over pumping of groundwater depletes aquifers and that climate change will require even more water. The view of energy from a water perspective might reveal that energy generation degrades water quality. Thus, energy portfolio decisions have consequences for water resources and require a debate about these trade-offs. Similarly, looking at water from an energy perspective highlights an ever increasing demand for hydropower, while looking at food from an energy perspective reveals that climate change will require more refrigeration of food, which makes local food sources preferable to long distance ones. What shifts in agricultural production will be needed as the climate changes? Is there enough water available in new agriculture production zones? Are urban demands rivalling agricultural demands for water?

Dr Scott discussed what he called 'vicious cycles' and 'virtuous cycles'. In vicious cycles, one use of a resource detracts from another use: hydropower generation degrades water quality and river health; cheap electricity combined with no incentives to conserve leads to over-extraction of groundwater. Using the WEF nexus might promote more virtuous cycles, mitigating the harm use of one resource has on another.

A more detailed report by Dr Scott on the complexity of water-energy-food interrelationships and how the approach can be harnessed for sustainable development is contained in Annex IV.

## Presentation: *Dr Bill Young*

### Lead Water Resources Specialist, World Bank

Dr Bill Young, the World Bank's Lead Water Resources Specialist, sees river basin planning, specifically of the Ganges basin, as an important way to get a handle on the complexities of managing the WEF nexus in the South Asian context. He cautioned that even looking at the region's issues through a river basin lens does not simplify the challenges. Each area has unique qualities of river flow variability, agricultural productivity, and climactic variability; but all countries in the region experience challenges created by the monsoon, extreme variability in river flows, as well as sewage mismanagement and river pollution.

*Dr Bill Young, Lead Water Resources Specialist, World Bank*

The Ganges basin:

- encompasses 800,000 square km
- is the most populated river basin in the world (with 700 million people)
- is characterized by extreme poverty
- contains nearly 50% of India's population, 100% of Nepal's, 27% of Bangladesh's population in the greater basin
- has 80% of its rainfall in during the monsoon, which is 3–4 months of the year
- uses 90% of its water resources for agriculture/irrigation

Agriculture employs the majority of the population of the basin, but does not provide proportional economic benefit. Groundwater in the basin is overexploited, especially in India and hydropower remains undeveloped and unevenly developed in the region, although many people still lack electricity.

Even though India has a large food production system, it remains a food deficit country. Nepal has a food deficit, particularly in the mountains. Bangladesh also has a food deficit because it relies on low productivity agriculture. Food production is not really constrained by water availability in the Ganges basin; the problem is that water is used inefficiently. Theoretically the same amount of water could feed twice as many people. Throughout South Asia, inefficient use of available water is compounded by other problems, including poor soil quality, pointing to a need for better water management.

Decoupling food security from increased water use can help promote the sustainable use of water. Similarly, economic growth should be decoupled from increased use of water. Demand for water will continue to grow, but the resource is finite.

In India, 15% of food production is based on unsustainable groundwater extraction, especially by wealthy farmers. In other areas, diesel pumping of water is limited by fuel prices. It is important to explore aspects of pricing in connection to the nexus. For example, would it change farmers' behaviour if electric pumps were replaced by solar pumps?

Analysing trends in the basin in light of the nexus will lead to better understanding and planning. For example, with new dams there will be additional energy produced, as well as more consumption, along with the environmental impacts of construction, reservoirs, and reduced river flows. It is not clear, however, whether food production will also increase.

A lack of reliable data, especially related to water resources, plagues planning and decision making in South Asia. Data is often contradictory and hard to access. Cooperation among countries will be hampered until there is more reliable data and countries are more willing to share it. A strategic water basin plan requires:

- reliable shared data
- a shared vision for the future
- accountability
- monitoring and evaluation
- decisions about which legal authorities apply
- processes for stakeholder engagement

In short, says Dr Young, the Ganges basin has a huge water resource base that is critical to food and energy security. However, the increasing demand on this system calls for effective planning, shared data, and innovative ways of decoupling different aspects of the WEF nexus.

See Annex V for Dr Young's complete presentation.

*Professor Ethan Yang, Research Assistant Professor, University of Massachusetts, Amherst*

## Presentation: *Professor Ethan Yang*

### Research Assistant Professor, University of Massachusetts, Amherst

Dr Ethan Yang, Research Assistant Professor at the University of Massachusetts, Amherst, noted that the world will need 50% more food, 40% more energy, and 30% more water by 2030. The situation will be even more challenging for South Asia, given its complex hydrological regime, which is dominated by monsoon variability and receding glaciers, combined with its transboundary tensions.

Dr Yang says systems modelling can contribute to strategic river basin planning in the face of such challenges. Systems modelling allows the quantification of the water-energy-food nexus and helps us to evaluate the impacts of climate change and human developments on this nexus. It uses models to identify historical values and then quantifies the changes in these numbers following climate or anthropogenic influences. This data can be used to assess security and sufficiency. A great deal of varied data is needed to help build the model structures so that they can incorporate human decision making and policies.

Dr Yang outlined issues and models specific to the Indus and Brahmaputra river basins. The purpose of his research is to make cross-basin comparisons to investigate how human development will affect water and energy use. The models can also help assess security issues for those basins.

The model of the Indus Basin assesses Pakistan's water-energy-food relationships, in particular the trade-offs between water uses for crop production versus hydropower generation. Using a variety of inputs (for example, agronomic, irrigation system data, water inputs) to generate the optimal crop production across the provinces (subject to a variety of physical and political constraints), changes in management practices for crop production, and hydropower generation were analysed to determine impacts within the WEF nexus. Testing incorporated three water infrastructure systems and three water governance programmes.

Results indicated that the current water allocation system does not pose significant trade-offs between agricultural and hydropower objectives, as there is no flexibility in the water allocation and reservoir operational rules. If water allocation policy is changed, more surface water will be used. In addition, if new systems (hydropower) are built, more hydropower will be produced, and if water allocation policy is changed, there will be more wheat and sugarcane production (with the caveat that it is for annual mean results only). However, trying to determine how system changes will affect year-by-year consistency, not just long-term tendencies, is much more difficult to determine. Studies can extend the analysis by incorporating a complete energy market into the model and addressing future climate, demand, and price uncertainty.

Compared to the complexities of the Indus basin, the Brahmaputra is heavily affected by another layer of uncertainty – climate change. Dr Yang wanted to see whether the system would respond to different temperature and precipitation changes. The model in this case was constructed to test the outcomes of additional water diversions after new infrastructure was built: two new dams in China, four new dams in Bhutan, and four new dams in India. The results illustrated that climate change impacts were not an important factor in hydropower and crop production.

Dr Yang said that both basins need more data for modelling, which will inform security issues. These include tables of long-term average and inter-annual variability, further research on how human development will affect water and energy use, and linking the energy market model to gain a more comprehensive picture of the entire system.

For Dr Yang's complete presentation, please see Annex VI of this report.

## Plenary discussion

During the question-answer session following the lectures by doctors Young and Yang, some additional ideas emerged and points were reemphasized. The highlights of the plenary discussion are captured in the following points:

- Data and evidence: We need to build an open, shared evidence base on the water resources in the Indus Basin and how they are being used. We need to identify opportunities for capacity building and training, before jumping into confronting discussions on transboundary negotiations. Dialogues should be basin focused and informed by better data and evidence. The modelling approach provides scientific support without political or social bias. The transboundary issues are being discussed at an international level.
- Transboundary management: The World Bank supports regional cooperation, but the majority of projects are at the country level. There is much that each country could and should do individually – managing their own issues better will eventually promote better transboundary management. The countries of the region are not likely to come together to cooperate until they are doing better at home. The need for energy may galvanize cooperation.
- Groundwater extraction: Regulating groundwater pumping/use is a major challenge as there isn't much data on the locations of wells and assessments quickly become outdated. Remote sensing shows huge groundwater depletion in the Punjab. There are transboundary dimensions to this, as depletion in the Indian Punjab has impacts across the border in Pakistan. A heavy government subsidy (85%) for solar pumps is providing a clear incentive for farmers to over-extract groundwater, but there is no incentive to responsibly use groundwater.
- Modelling of the nexus for the Indus: The Indus River has major upstream-downstream sharing issues, even though a treaty with India governs water use. Nexus modelling can be used to address some issues, but not necessarily the water sharing issue. The nexus may not be the best analytical tool to address water sharing.

## Special remarks: *Mr Peter Bodde, US Ambassador to Nepal*


*Mr Peter Bodde, US Ambassador to Nepal*

South Asia is one of the most water stressed regions in the world. Per capita water availability has fallen by 70% and demand is increasing. Regional water tables are dropping and unpredictable hydrological cycles and climate change exacerbate the challenges. Understanding the dynamics of the WEF nexus and using it to our advantage is critical to the wellbeing of people, especially those living in South Asia. Developing Nepal's hydropower resources will boost economic growth, but this kind of development has challenges. Critical bills need to move forward and the electricity grid needs major improvement. Nepal and India have recently signed a power trade agreement and negotiations are under way for more. Sustainable access to water, energy, and food is a global challenge that calls for cooperation at community, national, and regional levels.

## Group activity: River basin nexus modelling

In the afternoon, participants had a chance to experiment with two of the World Bank's software tools: an integrated water resources management tool called BasinIT and a mobile app called Spatial Agent. These tools are used for balancing the different needs of the many water users. The goal is to use water as an integrating resource across different users to handle the complexity we see around us and to reconcile changes that are already happening, such as urbanization and land use change, with the systems to manage them.

### BasinIT

BasinIT (Basin Interactive Training Tool) is a hands-on interactive training tool for basin water planning. BasinIT allows you to simulate various water management decisions and see their impact on water allocation, economic benefits, and the environment. It uses the hypothetical 'Hope' basin to help people from different sectors and regions work together to get a sense of interconnections. It helps to show linkages among agricultural policies and water demand. It explores some of the complexities of the WEF nexus. Combinations of options can be analysed from economic, social, and environmental perspectives to illustrate trade-offs and synergies.

### Spatial Agent

This mobile app pulls together available information into one platform; for example, country-level indicators such as GDP per capita. The app itself has no data, but draws on different services, which the user can see. Population data comes from Columbia University and precipitation data from NASA. There are thousands of datasets of general interest as well as sub-national data. The app develops maps and allows users to click on countries and obtain time series data and interact with that information.

For more information on the BasinIT and Spatial Agent, see Annex VII of this report.

*Women engage in farm work, Birgunj, Nepal*

## Panel discussion: River basin perspective on the WEF nexus

The panellists in this discussion included Shakil Ahmed Ramay, Head of Climate Change Study Center, Sustainable Development Policy Institute, Islamabad; Dr Jiang Tong, Professor, National Climate Center, National Center on Climate Change, China Meteorological Administration; Dr Ravinder Kaur, Director, IARI (A) and Project Director, Water Technology Centre; and Mir Sajjad Hossain, Member, Joint Rivers Commission, Bangladesh. The chair of the panel, Dr Christopher Scott, summarized the panel participants' comments as follows:

- Local solutions using integrated water resources management and the WEF nexus could be applied in the basin context and brought to the regional level.
- Efficiency gains must be evaluated before we can engage in the efficient management of resources.
- We need to devise cost effective, decentralized tools for water management.
- Policies should be informed by scientific modelling results, as well as the principle of equity. Equitable access to water resources can take on several dimensions including socioeconomic, gender, and spatial (upstream/downstream) dimensions.
- Water lies at the core of the WEF nexus. It is important to take extreme events – floods and droughts – into account. We need early warning systems.
- Integrated basin planning should take into account the risks associated with climate change, along with uncertainty in the availability and reliability of data.
- Transboundary river basin management needs to be addressed in a cooperative manner.

The question and answer session that followed the panellists' remarks highlighted some additional ideas:

- Water quality is just as important as quantity – both locally and in terms of lower riparians.
- Low efficiency and the resulting low productivity can lead to a great loss of resources and money – but not all inefficiencies are the same. In terms of water inefficiencies, some losses can be recaptured downstream or in groundwater. However, energy losses cannot be recaptured.
- Yet efficiency should not be our only goal; equity is also important. Efficiency alone can marginalize the poor and especially women. How do we bring efficiency and equity together to avoid the risk of not having equity in terms of time, space, gender, and for youths?
- How does human migration impact on development and wealth generation? What is the connection between migration (internal and to foreign countries) and the availability of resources and their use? Environmental conditions that cannot support livelihoods and food security drive migration. Other aspects to migration include the feminization of labour and vulnerable families.

# Day 2. The Social Lens

The second day of the workshop focused on the WEF nexus through a social lens. The opening remarks by session chair, Dr Eklabya Sharma of ICIMOD, highlighted several salient issues for participants to consider during the day's discussions.

Upstream and downstream regions in South Asia are linked by rivers and water; the needs of people in the upstream and downstream areas cannot be considered separately. The population of the Hindu Kush Himalayan mountains is 210 million, but most of the region's three billion people reside in downstream areas. Upstream communities may be self-reliant in terms of food security for five to seven months of the year, but they rely on food resources from downstream during the winter months. Even when the need for food is satisfied, vast populations throughout the region still have serious nutritional deficiencies.

Rivers originate upstream, but most of the irrigated regions are downstream in the floodplains of the Ganges and Indus, constituting the most irrigated region in the world. Because poverty dominates in both upstream and downstream areas, the entire population is vulnerable. Developing institutional capacities and governance is a major challenge throughout the region, made even more complex by the high dependence on water and the upstream-downstream sharing paradigm.

While hydropower from upstream areas is an important source of energy, especially for those in the downstream, a large part of the mountain population also depends on biomass. The efficiency and affordability of clean and safe energy are important issues to debate during the workshop.

## Keynote address: Dr Aditi Mukherji

### Theme Leader, Water and Air, ICIMOD

*Dr Aditi Mukherji, Theme Leader, Water and Air, ICIMOD*

Dr Aditi Mukherji, Theme Leader, Water and Air, ICIMOD began her address by noting that the role of the Himalayas is too rarely discussed, even though the mountains provide water and food, as well as the potential for energy, and are thus central to discussions on the WEF nexus in South Asia.

The Hindu Kush Himalayas is the source of 10 major river basins in Asia, supporting one of the world's most extensive irrigation systems. The mountains are thus vitally connected to the region's food security. They also have enormous hydropower potential. Hydropower is the dominant source of energy in the eight countries in which ICIMOD works. Although India, Pakistan, and Bangladesh currently rely mostly on thermal power, hydropower is the dominant source of power elsewhere in the region.

How do we provide energy in an environmentally sustainable way, with the least amount of damage in the mountains and the maximum benefit to mountain people? This is a key challenge in developing hydropower in the region. However, the limited focus on policies that support benefit sharing between upstream and downstream remains a major barrier to the sustainable development of hydropower. The current focus is on national energy security (or at best, bilateral trade), with insufficient attention paid to regional trade and cooperation on energy.

Dr Mukherji warned that the neglect of mountain concerns in policy discussions could take the same course that unplanned groundwater extraction for agriculture has taken in India in recent decades. The lack of concern for the consequences of heavy groundwater pumping has led to a crisis, resulting in severe depletion of groundwater in some states. Since the 1970s, the area irrigated by groundwater in India has increased, as has the number of wells and tube wells; in 1987 there were 6.5 million wells, now there are 20 million.

Electricity used in agriculture has become India's Achilles heel. The link between groundwater and energy is obvious; power is needed to bring groundwater to the surface. Increased access to electricity has led to increased reliance on groundwater and the overexploitation of groundwater in many states. The availability of electricity to farmers combined with electricity subsidies to pay for the pumping of groundwater has led to groundwater depletion as well as a growth in electricity consumption in agriculture, which has outpaced consumption in other sectors. There was a 12-fold increase in overall electricity demand in India between 1950 and 2010, but a 25-fold increase in agricultural electricity demand. This dynamic has led to fiscal deficits in many of the states where farmers get free or highly subsidized electricity. The net electricity subsidy in India is close to USD 9 billion and is rising each year.

Agriculture is often blamed for the poor state of electricity utilities in India, yet farmers receive poor quality service as well. Further complicating matters, there is an energy divide: farmers in eastern India depend on diesel pumps, while the rest of India has electric pumps. The result of these trends is a nexus whereby the agriculture sector is dependent on unsustainable trends in both groundwater and electricity use.

Different solutions to these unsustainable trends have been attempted in different states. The context of each attempt to correct unsustainable trends defines the nexus problem and dictates its solution. Three examples of energy-side interventions aimed at solving the groundwater-energy crises are discussed here: West Bengal, Punjab, and Karnataka.

### West Bengal: The first state to meter electricity to reduce the amount of electricity used to pump groundwater

West Bengal has an alluvial aquifer, along with high rates of rainfall and recharge. Groundwater tables recover after the monsoon so groundwater depletion is not a big problem, but electricity has been used unsustainably. Until 2007, a flat tariff was charged for pumping water, so there were no constraints on pumping. In 2007, West Bengal became the first state in India to meter electricity as a way to alter consumer behaviour using Universal Time of the Day (TOD) metering for all agricultural tube wells.

Until March 2010, 90% of tube wells were metered using high tech remote readings to avoid tampering with meters and bribery. Farmers who owned pumps were happy because they paid less for the same hours of pumping, but were able to sell water at the same or higher or prices and had better bargaining power with water buyers. However, those farmers who had to buy water lost out because the pump owners increased water charges by 30–50%. Water efficiency increased with the adoption of plastic pipes, better maintenance of field channels, and the construction of underground pipelines. But the question remains: will this method save water?

### Punjab: Government rations electricity with two sets of lines

During the 'green revolution', farmers in the Punjab changed from their more traditional crops to wheat and rice. While this change is at the heart of the Punjab's agricultural prosperity, the wheat-rice cropping districts closely mirror those areas where groundwater is overexploited and depleted.

Metering of electricity was not possible in the Punjab because of a strong farmers' lobby. Instead, the government rationed electricity by using separate lines for domestic and agricultural connections. Agricultural users received power two to six hours a day. Domestic users were not rationed. The result was good quality, reliable electricity. But some agricultural users switched to diesel. Electricity transmission and distribution losses have decreased marginally, but the state's burden for subsidies keeps rising because it continues to approve new electric connections.

### Karnataka: Attempted solution failed; groundwater use increased

Karnataka has hard rock aquifers and low rainfall. The state tried to copy the Punjab system of separate feeders, but, due to poor design, the attempt failed. Energy audits also failed because in the absence of feeder segregation there was a mixed load and no proper way to estimate agricultural energy use. The result was chaos below the feeder level and farmers were easily able to illegally tap into electricity. As a result, the number of connected pumps has increased and the area of groundwater usage for irrigation continues to increase with the number of electric pump sets.

Although the broad issues involved in overuse may be the same, but different states in India have managed, or mismanaged, the problem differently. The success of any WEF nexus scheme depends both on context and political will and governance.

For Dr Mukherji's full presentation, please see Annex VIII of this report.

## Interactive dialogue café

Following the day's keynote speech, workshop participants had an opportunity to discuss various WEF nexus trade-offs in small groups. Session chair, Dr Philippus Wester of ICIMOD, noted that South Asia is unique: it is blessed with sufficient resources, but many challenges plague the region and make the use of these resources problematic or unsustainable. The session began with panellists giving five-minute presentations or 'pitches' on a specific approach to a WEF issue. Workshop participants chose one of the seven topics and reconvened at the end for a brief recap by each group.

### Group 1: **Local trends and the WEF nexus, with panellist Dr Aditi Mukherji, ICIMOD**

The pitch: Following up on the case studies in Dr Mukherji's keynote address, each participant in this group was asked to identify nexus problems (and potential solutions) from his or her country or region.

Recap by group: In general, participants agreed that it is important to consider the priorities of domestic use versus industrial and agricultural use. Usage is contextually variable and changes over time.

- In Bangladesh, transient land masses in coastal areas where vulnerable people try to live present challenges including high water salinity, limited agriculture due to low water quality, as well as general energy, water, and food insecurity.
- In Nepal, the government has subsidized wells in the Terai, but farmers are not taking advantage of this irrigation potential, possibly because the cropping patterns are mismatched. The result is too much fallow land.
- In Bihar, a large landless population does much of the farming; landowners get rent from the use of land and water. How to break these linkages? Can land and water be delinked? Land reform is hard to accomplish.
- In urban areas in the Ganges, current programmes for cleaning the Ganges do not necessarily address agriculture. There may be potential for generating energy from wastewater and as well as using it for agriculture.
- In Andhra Pradesh, the monsoon's shifting pattern is affecting agriculture and cropping systems have been almost at a standstill for the last two seasons. Food prices have increased and government subsidies are needed to rationalize electricity. A possible alternative could be the System of Rice Intensification (SRI), which requires less water and has higher yields. Another possibility is to try shifting the seasonality of different varieties.
- In West Bengal, the government provides an 85% subsidy for solar technology/generation, but this requires land, which farmers lack. Land is one issue; cloud cover during the production season is another, which means solar is not helpful during the main rice season. One approach could be to incentivize water sellers to switch from diesel to solar pumps, but if solar pumps become feasible does that mean there will be freedom to pump more?

### Group 2: **The role of (international) water law in creating the WEF nexus: Is it useful or not? What is its potential to manage the nexus? With panellist Dr Christina Leb, Senior Water Resources Specialist, World Bank**

*Dr Christina Leb, Senior Water Resources Specialist, World Bank*

The pitch: International water law is based on the equitable and reasonable use of water in the transboundary context. These laws take into account existing and future users among the populations that depend on the water, along with social and economic uses of the resource. There are several multilateral agreements and regulatory frameworks in South Asia for managing transboundary water resources, but law may not be the perfect tool to manage water agreements. International treaties look at multi-purpose projects that integrate needs, but these treaties are not always easy to implement. Laws may not reflect environmental or agricultural concerns. In the national context, law can integrate the WEF nexus, but law does not play that role in all countries.

Recap from group: The group decided to discuss laws at the national level to see if different countries are using laws to address nexus issues. The general conclusion was that they are not, partly because most laws are very old, in some cases dating back to colonial times. New laws need to be formulated in South Asia in light of the WEF nexus with 'nexus ministries' playing a key role in the exercise. Not all countries even discuss water rights. In formulating clear water rights, obligations must be formulated as a correlation to rights; for example, the obligation not to pollute.

In South Asia, existing laws often apply across a whole country without accounting for regional differences, although in India water law is a state issue and the federal government can only advise. Also, government institutions are too removed from the districts where people live, work, and grow food. Not only is there a lack of connection between the national and local levels, but the ministries that oversee resources are also disconnected. In Nepal, departments for agriculture, energy, and soil conservation work in isolation and act independently in governing all resources. Bangladesh is similar to Nepal. The formulation of laws never takes into account the WEF nexus perspective, because formulation usually happens in isolation.

*Ganesh Pangare, Regional Director (Asia-Pacific), International Water Association*

### Group 3: **Talking trade-offs: Policy drivers that can improve cooperation and benefit sharing, with panellist Ganesh Pangare, Regional Director (Asia-Pacific), International Water Association**

The pitch: Social values and trade-offs should be more central to resource discussions. For example, hydropower is typically seen in terms of national energy security, but what are the benefits for people at the local level? The WEF nexus approach helps to create a dialogue between different sectors – agriculture, water resources, and energy – but what about equity? And whose equity are we talking about, the poor and marginalized or the wealthy? In the real world, trade-offs are mediated by power dynamics. From a policy perspective, what are the drivers that can improve cooperation and equity? What are the different options for cooperation and benefit sharing? Can data democratization be a vehicle for cooperation?

Recap from group: Cost sharing and benefit sharing are equally important. At any level, cooperation requires building trust. Sharing important data can help create an atmosphere of trust and once trust is established it is easier to rely on the shared data. Lack of cooperation has consequences at all levels: for people, ecosystems, and governments. The repercussions of a lack of cooperation must be made clear. Examples of solutions that have worked and those that have not should be tracked.

### Group 4: **Critical drivers to increase the productivity and sustainability of irrigated agriculture, with panellist Arnaud Michel Francois Cauchois, Senior Water Resources Specialist, Asian Development Bank**

The pitch: Despite large-scale surface irrigation schemes in South Asia, agricultural productivity is low; a lot of water is used, but not much food is produced. Given the rate of population growth in the region, this trend is not sustainable. Because of inefficient water use, farmers are not able to rely on surface irrigation. Expanding the use of groundwater has yielded benefits, but has also led to the overexploitation of groundwater and unsustainable use of electricity. Pursuing low-value, water-intensive crops also leads to the overexploitation of water and energy.

*Arnaud Michel Francois Cauchois, Senior Water Resources Specialist, Asian Development Bank*

The reasons for such poor productivity are well documented: bad policy decisions, lack of institutional capacity, and irrigation departments that remain oriented toward construction instead of management. Furthermore, irrigation is still treated as welfare, rather than as a commercial activity. There are many design flaws in irrigation schemes, mostly due to outdated designs and lack of maintenance. Irrigation schemes generally lack measuring and control systems. We need to find ways to modernize and modify irrigation systems from a technical and IT point of view; systems are still paper based.

Recap from group: The group proposed various suggestions for what might improve the productivity of irrigated agriculture. A new generation of engineers who are management oriented, instead of construction oriented, is needed. Currently, there is no curricula for managing irrigation schemes. Reform is needed for government irrigation staff, such as performance evaluation criteria and merit rewards to motivate good performance. Collaboration with the private sector is another route; there are examples of such initiatives in Sri Lanka, India, and Bangladesh that could provide instructive. Farmers themselves need to better understand these issues. Public institutions need to be reformed as multi-purpose authorities.

*Ali Tauqeer Sheikh, Chief Executive Officer, LEAD Pakistan*

### Group 5: **Knowledge management and communication for policy action, with panellist Ali Tauqeer Sheikh, Chief Executive Officer, LEAD Pakistan**

The pitch: Given South Asia's many challenges – from groundwater depletion to flash floods, from internal migration to climate change – is it possible to decide strategically what aspect of the nexus is most critical and hence demands the maximum focus? Energy can readily be addressed in economic terms. Food security is more complicated; however, with the advent of new technology, there is reason for optimism because technological changes to systems can improve agricultural productivity. The average Punjab farmer in India produces seven times more than the average Punjab farmer in Pakistan, but the average progressive farmer in Pakistan produces seven times more than the average Punjab farmer in India – and Mexican progressive farmers produce even more. In the Pakistani context, the challenge is to live with half of the water, but produce twice the crop. How do we ensure that the knowledge from workshops such as these informs policy discourse and leads to action? How do we learn from each other and create a policy community to expand policy options? How do we reach out to stakeholders and ensure equity, sustainability, and regional cooperation?

Recap from group: The group made several suggestions in response to the panellist's questions. Information and specialist knowledge needs to be synthesized into an unbiased base of evidence, which could then serve as the basis for policy and action. Using new technology and innovations in communication could support this. Also, knowledge should flow upwards, which will require more open channels of communication among science, communities, and policy makers. The creation of neutral forums to discuss policy was suggested, as well as a forum to engage with policy makers. The role of the South Asian Association for Regional Cooperation (SAARC) could be strengthened. The list of stakeholders involved in making policies should also be expanded and their roles increased.

### Group 6: **How can we implement a WEF nexus approach in the current institutional setup? With panellist Dr Luna Bharati, International Water Management Institute**

The pitch: The usefulness of the WEF nexus as a concept is obvious, but implementation of this concept is difficult. At the household level, managing the nexus is easy, but beyond this level things fall apart. Different institutions and agencies manage food, water, and energy and these actors are all very territorial. For example, watershed resources recharge springs and tanks store water; but different actors do not want to build irrigation or install pipes for household water supplies because it is beyond their purview or mandate. So how can we begin to use the WEF nexus, given the rigidity of current institutions?


*Dr Luna Bharati, International Water Management Institute*

Recap from group: Participants pointed out problems that will need to be addressed in order to make use of the WEF nexus within institutions. At present, there is little coordination between various departments and ministries and they do not have an incentive to cooperate. Even when there is political will, it can be difficult to get people to change their mindset and behaviour. Interdepartmental agencies could coordinate cooperation among departments and provide incentives for it. They could foster mutual interdependence between departments and tie that to performance evaluations and reward systems. There are good examples of integration at local levels, which can inform design and implementation at other levels.

### Group 7: **Facilitating upstream/downstream cooperation, with panellist Dr Golam Rasul, Theme Leader Livelihoods, ICIMOD**

The pitch: From a socioeconomic point of view, the Himalayan ecosystem is a source of security for South Asia (food, water, electricity). However in South Asia the three nexus sectors are not integrated regionally, even though there are interdependencies among all regions. This raises questions of how to maximize synergies, create more opportunities, facilitate upstream downstream cooperation, and share data for mutual benefit.

*Dr Golam Rasul, Theme Leader Livelihoods, ICIMOD*

Recap from group: It is clear that in South Asia we need regional cooperation and a river basin approach that involves good data and knowledge sharing. But how do we make it happen? We need to overcome mistrust between countries to facilitate cooperation. We need not only data and knowledge sharing, but also an honest broker to facilitate the discussion of issues and an institutional mechanism to handle such discussions. Headwaters should be managed for joint benefit. The WEF nexus linking has to include consideration of transportation, because we must minimize the use of energy for the transport of food in the region.

## Briefing about ICIMOD: *Dr David Molden and Dr Eklabya Sharma*

In the afternoon of Day 2, participants visited ICIMOD's knowledge park, followed by presentations on ICIMOD programmes. ICIMOD belongs to a mountain partnership and has collaborated with mountain organizations in countries outside the region, such as Peru and Italy. The organization also works in partnership with local organizations that engage with communities. ICIMOD's work focuses on the Hindu Kush Himalayan region, which encompasses all or parts of Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Myanmar, and China. ICIMOD's main mission is knowledge dissemination and transboundary collaboration among these eight nations. The following points about the region were conveyed to participants during the briefing at ICIMOD headquarters after the visit to ICIMOD's Knowledge Park.


*Dr David Molden, Director General (right) and Dr Eklabya Sharma, Director of Programme Operations (left), ICIMOD*

- The Hindu Kush Himalayan region is a global asset, with water resources, energy potential, agriculture, and unique biodiversity
- About 210 million people live in the mountains of the Hindu Kush Himalayas and 1.3 billion people live downstream.
- The plains below the HKH region have great population density.
- More than 1,000 living languages are spoken in the region.
- The region is changing rapidly because of climate change and outmigration.
- The discovery of new species of flora and fauna in the region is ongoing.
- The region is data poor (snow, biodiversity), especially for data gathered using traditional scientific methods.

*ICIMOD Knowledge Park at Godavari*

Among ICIMOD's areas of investigation are studies of what is happening to the cryosphere, i.e., to snow and glaciers. ICIMOD is a pioneer in remote sensing work and collaborates with China in this effort. Many of the issues ICIMOD scientists study are not in the high mountains, but in the more populated mid-hills region. ICIMOD also studies black carbon mitigation, which offers multiple benefits throughout the region. The small particle air pollution from brick kilns and wood stoves that attaches to glaciers and promotes their melting is deleterious to health for the residents of villages and cities alike.

ICIMOD studies many aspects of climate change, including future changes in runoff from glaciers and snow. Dr Molden noted that the total volume of water available in the region may not decrease, but if glaciers recede significantly irrigation systems that now depend on meltwater may no longer be connected to that water source. Discussions of disaster risk are increasing in the region. Planners have to take landslides into account when planning hydropower. Climate change may lead to greater transboundary collaboration and ICIMOD will promote that through its work on policy and with scientists in the region.

ICIMOD has programmes for gathering data, helping countries develop, promoting the importance of mountain regions, and enhancing regional cooperation. The Kailash Sacred Landscape Conservation and Development Initiative and the River Basin Programme, for example, involve three countries: China, India, and Nepal.

For ICIMOD's full presentation, please see Annex IX of this report.

## Regional dialogue session

While most participants visited ICIMOD's Knowledge Park in the afternoon of Day 2, a smaller group involved in various regional dialogues met to reflect on past and future dialogues on South Asian water or on WEF nexus interconnections, climate change, and environmental concerns. They reported back on their discussions on Day 3.

# Day 3: The Institutional Lens

## Keynote address: *Mr Dipak Gyawali*

### Chair, Nepal Water Conservation Foundation

*Mr Dipak Gyawali, Chair, Nepal Water Conservation Foundation*

In the final keynote address of the three day workshop, Dipak Gyawali, Chair of the Nepal Water Conservation Foundation, reflected on the recent evolution of the WEF nexus concept and its utility. He pointed out that, in 2007, oil prices increased dramatically. And in 2007/08 the global financial crisis led to food riots after global food commodity prices crashed. These crises, along with a growing awareness of climate change, has focused intent interest on valuable resources such as water, energy, and food. These crises have also shown the weakness of treating those resources as compartmentalized commodities in a top-down management approach. Furthermore, a scarcity narrative is driving the discussion of the WEF nexus toward solutions that espouse control and stability.

Gyawali discussed the Melamchi inter-basin water supply project for the Kathmandu valley as a particularly good example of a project that was designed without any nexus ideas in mind. If a 'nexus-ed' approach is used for electricity in a country like Nepal where there are about 14 hours of power cuts a day, one would design a 'nexus-ed', multi-purpose project. Many experts, including from activist NGOs, have suggested this for Melamchi. Such an approach would include building a small hydro facility as part of the project. The much-needed electricity would pay for some of the project's costs and the plan would include a water treatment plant and would supply water downstream to the Terai where it is needed for irrigation. However, what is underway with the Melamchi Project is a de-nexused version, in which Kathmandu will get expensive water and the Bagmati river will remain a sewer; the Terai will get no irrigation; and the country will get no electricity. The river is sacrificed, but the benefit is minimal; social justice is lacking in this solution.

Gyawali noted that some problems facing us in the region are stuck, meaning no one can agree on how to define the problem let alone a solution. Anthropology and other important disciplines are marginalized in policy discussions, even though they could provide innovative thinking. Gyawali recommended some ideas that policy makers should keep in mind:

- Recognize that institutional limits are as important as environmental limits.
- Recognize that social, economic, and technological challenges will be more rapid and have more impacts on population than climate change.
- Innovations have to come not just in technology, but also in management and behaviours. Conventional approaches don't work anymore. Policies and treaties need to acknowledge realities.
- Storage of all the nexus resources may be the key that would provide many of the 10% solutions we need for a nexus-ed approach.
- Four types of water storage are needed: large dams, rainwater harvesting, groundwater storage, and storage through wetlands/soil moisture.

Please see Annex X of this report for Mr Gyawali's complete presentation, which is based on ongoing research and can be accessed at: http://steps-centre.org/wp-content/uploads/Water-and-the-Nexus.pdf and http://www.water-alternatives.org/index.php/tp1-2/1888-vol8/288-issue8-1.

## Panel presentation: The WEF Nexus through an ethnographer's eyes, *Mr Bihari Krishna Shrestha*

*Mr Bihari Krishna Shrestha, anthropologist*

Mr Bihari Krishna Shrestha, an anthropologist, said that two main points need to be made about the nexus approach in Nepal. First, because Nepal is overwhelmingly rural, the nexus should also include forestry. Second, in order to the make nexus work and have effective results, it should also include the component of governance. Mr Shrestha discussed two cases that illustrate his ideas.

### Jumla traditional rice germination system

Jumla District in Nepal, at an altitude of 3,000 metres, is the highest rice growing area in the world. As the warm growing season is limited, seed germination is fast tracked by soaking seeds in the river followed by accelerating germination on a heated kitchen floor. The seeds are then planted in carefully manicured seedbeds.

### Nepal's community forests

In 1957, Nepal nationalized its forests, which led to unhindered deforestation. By 1985, the country close to desertification. In 1988 the forest user group (FUG) concept was introduced, under which responsibility for the conservation and management of forests was devolved from the central government to local user groups. The FUGs promoted equal distribution of forest benefits such as timber, fodder, firewood, and money for poverty alleviation. Now there are 18,000 FUGs in Nepal and they have become one of the richest rural institutions in the country with an average income of 300,000 Nepalese rupees per year (approximately USD 3,000).

Both of these cases illustrate the advantage of arranging the relationship between the various components – whether water, food, forest, or energy – to ensure optimal and tangible benefits to the community. This can only be effectively managed under a decentralized system that empowers users with inalienable and decisive power. In other words, all relevant stakeholders need to be involved and receive benefits.

Given the stubborn persistence in South Asia of a feudalistic socioeconomic order – in which leadership is based on the convergence of high caste and class, leadership thrives on the extraction of resources, and politics and bureaucracy remain corrupt – the WEF nexus can be effectively managed only under a decentralized system that empowers users. Community empowerment is the difference between a hypothetical and a practical nexus. Building nexuses at a supra-country level is only possible as an outcome of effective nexuses at the community level. The nexus should be built around the concept of accountability to communities. Aid agencies should focus on empowering communities and negotiating on behalf of a potential, effective nexus.

For Mr Shrestha's complete presentation, please see Annex XI.

## Panel presentation: The WEF Nexus through a legal and institutional lens, *Dr Dwarika Nath Dhungel*

In Nepal, local-level institutional arrangements are accomplished through village development committees (VDCs) in conjunction with district development committees (DDCs), which the main planning and administrative bodies. At the local level, there are governance bodies with a district chairman and representative who are supposed to coordinate planning and programming related to food, water, and energy; but the planning process doesn't involve coordination among the concerned agencies. Unfortunately, there have been no local elections in Nepal since 2002, so irrigation, agriculture, and energy agencies are working independently. There is no nexus approach at the local level.

*Dr Dwarika Nath Dhungel*

The Government of Nepal established a Water and Energy Commission (WEC) in 1975. The primary responsibility of the WEC is to assist the Government of Nepal, different ministries relating to water resources, and other related agencies in the formulation of policies and the planning of projects in the water and energy resources sector. The WEC is supposed to coordinate activities related to water, energy, drinking water, and other uses of water. However, the WEC was established when there was a Ministry of Water Resources – which has since been split into the Ministry of Energy and the Ministry of Irrigation. As a result, water-related activities, which were supposed to be planned in a coordinated way, are now totally disjointed. Food does not come under the purview of the WEC. For all practical purposes, the WEC has become a staff or aid agency of the Ministry of Environment. Furthermore, the Ministry of Irrigation has become part of the WEC and the WEC has nothing to do with resource allocation. The WEC has become a body whose recommendations are generally not pursued. Since 2014, there have been no meetings or coordination with governing bodies. For coordination on nexus issues related to water and energy in Nepal, we need to re-establish the Ministry of Water Resources.

For Dr Dhungel's complete presentation, please see Annex XII of this report.

## Remarks: *Mr Nisar A Memon*

### Chairman, Water Environment Forum, Pakistan

Mr Nisar A Memon, Chairman of the Water Environment, Pakistan, said that there are many disconnections among water, food, and energy in Pakistan, especially in terms of geography and governance. In 2008/09 the 18th Amendment to the Constitution devolved 17 federal ministries to the provincial level. Power over 'nexus' institutions was distributed from the federal government to the provinces.

*Mr Nisar A Memon, Chairman, Water Environment Forum, Pakistan*

In terms of water institutions, Pakistan has the Ministry of Water and Power, which manages water for hydroelectricity when it is stored. At that stage, the nexus of water and energy are recognized. But after energy is created and the water descends to farmers, it is separated and water is managed by irrigation departments in the provinces.

The Indus Basin Treaty (1961) between India and Pakistan determines how much water comes to Pakistan. Then there is an accord between the provinces called the Water Apportionment Accord of 1991, which determines how much water will go to each province to be managed by the provincial irrigation department that oversees the canal system. Pakistan has the largest irrigation system in the world. Provincial authorities govern water development along with supply and sanitation.

An institution called the Indus River System Authority (IRSA) serves as a mechanism for dispute resolution between the provinces. Every 10 days, data on water use is distributed from the IRSA to the irrigation departments at the provincial level, to field watercourses, and then back to the central offices and the IRSA. This is a complex system and, due to the disconnects within the system, accounting and data sources often become muddled. There are continuing issues such as insufficient and inefficient water storage, groundwater depletion from over pumping, and surface water usage that is unsustainable. The government's approach is to talk in terms of water, energy, and security but not about the nexus.

Pakistan has continuing issues, such as insufficient and inefficient water storage, groundwater depletion from over pumping, and unsustainable surface water usage. The Government of Pakistan has come out with a Vision 2025, wherein water-energy-food security is defined as a priority area of focus, but without direct reference to the WEF nexus.

*Ms Kusum Athukorala, Chair of NetWater and the Sri Lanka Water Partnership*

## Remarks: Reimagining institutions, *Ms Kusum Athukorala*

### Chair of NetWater and the Sri Lanka Water Partnership

Ms Kusum Athukorala, Chair of NetWater and the Sri Lanka Water Partnership, began her presentation with reference to two formal actions in the World Environmental Forum that relate to using the WEF nexus: reimagining institutions and new models for collaboration to make policy changes. She also noted three words, which she said she had not really heard at the workshop: corruption, gender, and politicians.

Politicians are missing in our discussions, but if we are talking about governance and policy making, politicians are necessary. We also have a growing population that will need more food. But what really happens to the food that we grow? How much reaches the people who need it? Post-harvest losses are enormous, so shouldn't we be trying to make sure that what we grow actually reaches the population?

In South Asia's post-colonial countries, departments tend to work in silos. Colonial regimes gave us a divide and rule system and this system is still internalized in the way our departments work. They are so compartmentalized that it is rare to have an initiative where everybody sits together and works on a common project. To effectively manage the nexus, a more integrated approach will have to be adopted, both in terms of scientific collaboration and also in terms of changing mindsets and administrative systems.

One major mindset change that is needed relates to women. Token references to women are made, especially to 'poor, landless women'. We need to turn this around and see that women have great strength and are constantly facing adversity in the day-to-day challenges typical of South Asian life for most women, especially rural women. If we have so many constraints and challenges concerning the WEF nexus and other issues in South Asia, does it make sense to continue to try to meet them with only half of humanity? We need to reach out to women from poor and marginalized communities who are highly vulnerable to disasters and extreme events, but who also have valuable knowledge. Finally, we must include the environment and forests in the nexus.


*Dr M Dinesh Kumar, Executive Director, Institute for Resource Analysis and Policy, India*

## Remarks: *Dr M Dinesh Kumar*

### Executive Director, Institute for Resource Analysis and Policy, India

Dr M Dinesh Kumar, Executive Director, Institute for Resource Analysis and Policy, India, described what he calls an 'unholy nexus' among academics, bureaucrats, and institutions in South Asia. Breaking this unholy nexus is part of our task. In policy circles, many believe that subsidized agriculture offers the best chance for ruling parties to participate in the benefits of the World Bank. Raising the tariff for pumping water would cause the price of water to go up in the market. Subsidies are important for farmers and politicians find this argument convenient. Academics perpetuate the idea that the implementation of tariffs is costly. If prices cannot be borne by poor water buyers, subsidies are necessary. Raising power tariffs would thus be political suicide – an argument that is very convenient for some.

Farmers tend to optimize their output by allocating water to high value crops; to make land more productive, farmers take more risks and modify their systems when confronted with higher costs. The price at which water is sold is determined by basic monopoly economics.

What about energy rationing through pre-paid meters? Power supply rationing is not working in Gujarat; there has been a shift from over-ground to underground theft. The externalities of canal irrigation are so immense that they outweigh the costs of pumping irrigation. The dominant group says that we don't need to build more surface irrigation, as we can rely on groundwater and then recharge it – but this is a fallacy. The new fashion is to provide free power connections to poor farmers so that they can pump groundwater at a very low cost. The limiting factor is land. The landholdings of poor farmers are too small to capture any benefits; but the rich can capture the benefits by switching from diesel to electric pumps and sell the power to poor farmers.

## Q&A session

The following are some of the highlights of the question and answer session:

- Nepal's hydropower potential should be developed first for domestic consumption, then for export.
- Communities have a role to play in hydropower development. The people at the bottom of the WEF nexus must be empowered before benefits can be taken from large hydro projects.
- Regarding the value of international treaties, water sharing must be worked out before hydropower facilities involving the two countries are designed.
- Many poor people live upstream without irrigated land. We need mechanisms to compensate mountain people.
- International treaties can work if they are negotiated through consensus, taking time to incorporate the needs of many stakeholders.

## Focus group discussions: How can research or action programmes by academics, NGOs and the private sector support government use of the WEF approach?

Following the panel presentations on institutional barriers to a WEF nexus approach to managing resources, small groups gathered to discuss the questions posed by Dipak Gyawali. Eight discussion groups were organized to approach the questions either from a particular 'sub-nexus' or from a geographical region. Participants were then asked to consider two questions in their focus groups.

- Which physical and social science disciplines are missing in our discussion of the WEF nexus and sub-nexuses?
- What strategies can help inject some of this research and personnel into government agencies?

Participants suggested a wide array of academic disciplines that have been largely overlooked in discussions of WEF resources, ranging from soil science and animal husbandry to anthropology, ethnic studies, and law. Many groups emphasized the need to bring various ministries together and the importance of broadening the education of specialists so that they are more likely to collaborate once in positions of authority. The groups pointed out that women are under-represented in all fields and in all discussion forums. Strategies for broadening participation included using local languages and better media outreach. Responses from each group are summarized below.

### Group 1: **Water and energy nexus**

- The energy sector and politicians are missing.
- We need incentives for ministries to work together, perhaps including performance evaluations that emphasize collaboration.
- We need more collaboration with social scientists for action research.
- We also need to figure out how to sensitize education programmes about how to work across disciplines.
- Evolving institutions are required.
- A deeper understanding of social issues is required by all involved in decision-making and implementation processes.
- We need gender representation at the local, ministerial, and research level; we need a gendered approach to research generation and implementation.

### Group 2: **Water and food nexus**

- The power sector, engineers, agricultural experts, soil examination, and animal husbandry are missing.
- We need more emphasis on agriculture and food aspects of the nexus.
- We need evolving institutions – ones that can adapt to changes and new thinking.

### Group 3: **Energy and food nexus**

- We need multidisciplinary education of experts to impart a theoretical and practical understanding of their own and other fields.
- We need a variety of disciplines represented during policy making.
- Gender representation in decision-making and representation of women's interests are needed (for example, men are interested in cash crops, but women often have other interests).
- Are ministries only implementing bodies or decision-making bodies as well?

### Group 4: **USA Mission – USAID**

- We need institutional arrangements between countries. Is it possible to have international treaties on water? An International Treaty on Shared Water exists, but only 36 parties/countries have agreed to it so far.
- We need to embed a WEF perspective in development projects, as WEF is a necessary component of sustainable development.
- Data democratization can help optimize resource management. Sharing data is crucial, on the regional scale, to accomplish a WEF analysis.
- Agencies generate a lot of data, but the challenge is linking it all together.
- WEF or WEEF (water, energy, environment, food) – should the environment also be part of the nexus? The environment can be a way of ensuring that the WEF concept reaches a broader group of constituents.

### Group 5: **UK-DFID**

- Crises can be both high-risk opportunities and motivators. However, how can we motivate and instigate action before a crisis?
- We need direct and clear communication with rural stakeholders.
- We also need communication with the government (e.g., through diagrams and visuals) to communicate science to policy makers.
- How can we navigate in the context of corruption and how can we ensure accountability to communities?
- We need to focus on the positive aspects of the WEF nexus, while at the same time recognizing the trade-offs.
- We need patience and persistence in communicating nexus ideas to policy makers, which requires consistent efforts over time.
- We need to convert the nexus into the economic losses that the government is incurring.
- Public opinion is important.

### Group 6: **Australia**

- Current discussions look mostly through the lens of water; energy and food are missing.
- Physical sciences are missing; people are missing, as well as psychology.
- We need to shift from optimization to resilience.
- Multidisciplinary stakeholder committees may be a way forward.
- We need to look at knowledge management and exchange – how to communicate research results?

### Group 7: **Bangladesh**

- Social science, anthropological, and engineering approaches are all important and should be explicitly represented.
- It is important to classify the WEF nexus into local, regional, and sub-regional levels. Poor people are affected at the local level, but at the government level they can be neglected.
- Basin-level thinking versus local and regional level thinking.
- There is a lack of coordination between the Ministry of Food and the Ministry of Water Resources; there is a role for the private sector to play in this dialogue.
- There is an overlap and conflict between the mandates of the government ministries dealing with WEF. Conflicts between sectors come from a non-integrated way of looking at things.
- At the field level ideas are not connected to the local people.
- Sociologists are in the organizational chart, but they are not employed in an effective manner. Social impact assessments (SIAs) and environment impact assessments (EIAs) are just a formality.
- Things are much more complex than they were 30–50 years ago, yet engineers are trained the same way. Engineers can also be social scientists or environmentalists if trained appropriately.
- Bangladesh focuses too much on its role as a lower riparian and the disadvantages of this role. Perhaps we need a more holistic view.

### Group 8: **India**

- The perspectives of marginalized ethnic groups and upstream groups are being omitted.
- Gender issues must be considered, including women's perspectives, rights, and access to credit.
- Anthropogenic factors also need to be included as well as water quality (not just quantity).
- We need to focus more on various disciplines: gender studies, anthropology, religion, ethnic studies, history (of resource use), law, and health.
- We need a better understanding of the traditional practices of mountain groups: How they are affecting the WEF nexus system? How do different ethnic groups use natural resources?
- Technology and innovation need to be communicated in local languages.
- We need science communicators in institutes and better communication with journalists.

## Plenary discussion: Various Track II water dialogues and discussion of regional water programme

In a final interactive session, participants again broke into several groups to discuss how to foster Track II and other dialogues in South Asia. The World Bank has been supporting a Track II Dialogue in South Asia for a number of years now, and there have been criticisms that perhaps this dialogue could be handled better. We have had government involvement, something more like Track 1.5. The Government of India will not officially engage in this process in its current form, so we are looking to repackage and reframe what this dialogue is about and how it is done. The participants have been convening on their own over the past few years (outside and beyond the World Bank). But what have we learnt? We need to focus on 'constructive influences' and success factors.

During their small group discussions, participants focused on the five areas for constructive action identified during the regional dialogue session on Day 2 and developed ideas that would support them. A summary follows.

### Clarity of purpose

- Why is the dialogue necessary? What are the goals and objectives?
- All stakeholders, major and peripheral, should be involved in reaching consensus on the objective.
- Objectives need to be prioritized and a timeline developed for outcomes.
- The vision can be global, but results should be local.
- The process of getting clarity needs to be dynamic and iterative. Revision is based on reflection.

## Political context

- We need to be aware of the history of the region and previous conflicts.
- We need to be aware of political mandates and institutional mechanisms.
- Multi-level engagement and the involvement of local people and politicians is required.
- We need to communicate the cost and trade-offs to communities and the wider public.
- The government has the overall mandate, but the Track II process needs to be enriched and expanded to include marginalized groups and their issues.

## Getting the right people

- The Track II dialogue needs policy makers, civil society actors, academics, and think tanks to be involved.
- The participants recommend forming an agency that bridges all people and clearly mandating this agency to deal with WEF issues.
- Whatever emerges from Track II should support Track I.

## Building trust

- We need to build trust by respecting divergent perspectives.
- We need to trust the convener of the dialogue, who should be an honest broker.
- All parties should define and declare the non-negotiables.
- We need to mutually agree on the negotiation technique.

*Rain water harvesting system, Bangladesh*

### Making an impact

- To make an impact we need to keep eye on the purpose and keep opportunities open.
- We need to make a breakthrough.
- We need to put national/international-level power trade agreements in place.
- We need Track II processes that are able to support negotiations.
- Start with the non-controversial issues – the 'low hanging fruit'.
- The highest level of impact would be a political breakthrough with effective implementation.

Additional ideas were solicited by Dr Undala Alam in response to the question: What is missing from the dialogues? These responses were recorded by Dr John Dore and included:

- Look for solutions, don't just rehash problems
- Take advantage of 'windows of opportunity'
- Find ways to get the ear of government ministers
- Build trust
- Involve the media
- Set up task forces and commissions
- Bring in new disciplines
- Respect the knowledge of others
- Be open to change
- Keep dialogue partners informed

## Special remarks: US Deputy Assistant Secretary of State, *Ms Fatema Z Sumar*

Climate change affects every aspect of food security. The United States is taking action to combat climate change – to reduce emissions and increase renewables. President Obama has announced new cooperation with China and India. The United States is focusing on working with countries in South Asia to boost local economies and sustain the environment for the benefit of the whole region. The next steps to be taken include:

- Get data: Achieve a better understanding of the problems and their impacts by gathering data and through open source data sharing.
- Deploy technology: Create energy from waste.
- Work together: Make sure that one solution in one sector does not create a problem for another sector.
- Use incentives: They work!

The full text of Ms Sumar's speech is in Annex XIII and can be found at: http://www.state.gov/p/sca/rls/rmks/2015/237429.htm.


*Ms Fatema Z Sumar, US Deputy Assistant Secretary of State,*

## The way forward: *Dr Bill Young, Dr Philippus Wester, and Mr Dipak Gyawali*

At the end of the three day workshop, the chief organizers summed up some of the positive outcomes of the workshop and indicated where work needs to be done in the future. The WEF nexus workshop in Kathmandu was an important first step; it began the job of building the kind of networks that will be needed for South Asia's water-energy-food future. Such networks will be vital for accomplishing interdisciplinary and transboundary breakthroughs in policy and practice; without them the problems South Asia faces cannot be solved. Simply by meeting face to face, sharing ideas, and listening to each other with respect and interest, participants have taken the first step. But there is much work to be done, and the energy generated at the workshop should be capitalized on with some urgency.

Neglected voices have been noted by various participants, including mountain communities, upstream communities, women, and marginalized groups. Their needs, views, ideas, and energy must be included, both in devising sustainable solutions and in implementing them successfully. As Dr Bill Young noted: "We need to work across silos and engage in planning and management with all the stakeholders: the winners and the losers." As some participants pointed out during the workshop, poor people are most affected at the local level; at the government level they can be neglected as plans that benefit larger entities and more powerful concerns move forward.

*Left to right: Mr Dipak Gyawali, Dr Philippus Wester, and Dr Bill Young*

Participants at the workshop also pointed out additional perspectives that will enrich a WEF nexus understanding of resources, such as forests, environmental values, and climate change. Furthermore, there is not just one WEF nexus, but many at various levels (local, regional, sub-regional). The concerns at one level can be very different from those at another level.

There are also entire disciplines often missing from discussions of water, energy, and food: these include anthropology, psychology, ethnic studies, animal husbandry, soil studies, and many other fields. Reforms in education that encourage or even require multidisciplinary training for experts who will be working on WEF nexus policy and planning must be undertaken right away.

A lack of multidisciplinary training penetrates to the highest levels of government, where ministries working directly on WEF nexus concerns do not collaborate or even talk to each other. As Dipak Gyawali noted, "There is a great need for collective decision making; one that is informed by nexus-sensitive knowledge and information". He continued:

> *Institutions that should be working with WEF-nexus issues better are not doing so. Commissions and task forces have not worked. There is a serious lack of communication among various people, levels, disciplines, and departments. This lack of communication has led to a lack of trust, creating another serious cause of malaise that we need to transcend.*

The importance of finding bridges that can lead to productive work with politicians was emphasized. Politicians at the local level have to be brought into planning along with those at state and federal levels. Efforts to create such bridges should be uppermost in participants' minds as they continue their own work.

There was some progress made during the workshop in understanding how Track II dialogues could be set on a more fruitful course and how to shape future dialogues. Some of the ideas discussed were highlighted in the plenary just before the wrap up. Having identified some of the people and disciplines that are missing and that must be incorporated into future WEF discussions, including Track II dialogues, the next issue for participants to work on is how to incorporate them.

As several participants pointed out during the workshop, good planning requires reliable, accessible data. Dr Bill Young noted that the World Bank "is supporting high quality data and technical analysis as a basis for our operations". Young also supported the idea of using river basins as "a useful way to frame integrated approaches". He said that, "As the major river basins in South Asia are all transboundary, the Bank is working to improve the quality of basin planning, and seeking to connect countries through their experiences in river basin planning". "But transboundary efforts would be more successful among countries that have gotten their own houses in order; much can be done within your own countries to improve processes," said Young.

One promising next step could be sub-basin meetings along the lines of the current workshop, incorporating some of the suggestions made during the last session about how to make Track II dialogues productive. Dr Philippus Wester of ICIMOD noted: "These are big basins, so sub-basins make sense. We might have a road show of sub-basin dialogues." He suggested that the Koshi Basin might be a good place to start, inviting China and the World Bank to join ICIMOD in its current efforts. "It doesn't have to be big, or something we need funding for; it is something we can just start doing," Wester said.

In concluding the three day workshop, Dipak Gyawali said he believed that WEF nexus discussions and approaches are particularly important in three specific ways. First they are needed for creating a new and broader education for people working in these fields. "That education would be conducted both in universities and outside of them", he noted, adding that "much of the knowledge generation is happening in NGOs, think tanks, and media". The debate and discussion of the WEF nexus will also be important for global regime debates within organizations like the United Nations. It is important for the people who gathered at the workshop to be involved in these regimes.

Finally, and almost prophetically, given the crisis in Nepal after the April earthquake as well as recent floods in Uttarakhand and Pakistan, Gyawali concluded: "This debate and discussion are going to be leveraging crises and danger: earthquakes, droughts, floods. This is when institutions are open to reflection. Be ready to exploit that window before it closes."

# Reference

World Water Assessment Programme, United Nations; UN-Water (2014) *World water development report 2014*. Paris: United Nations Educational, Scientific and Cultural Organization

# Annexes

# Annex I: **Agenda**

FULBRIGHT
WATER-ENERGY-FOOD NEXUS
REGIONAL WORKSHOP

**Kathmandu, Nepal: Godavari Village Resort**
**February 10–12 2015**

**DAY 0 February 9, 2015**

| | | |
|---|---|---|
| 18:30 – 20:00 | Reception and Welcome from U.S. Embassy Deputy Chief of Mission | SUMERU RESTAURANT |

**DAY 1 February 10, 2015**

| | | |
|---|---|---|
| 9:00 – 9:30 | Registration | SUMERU HALL |
| | **INAUGURAL SESSION**<br>Chair: **Dipak Gyawali** | SUMERU HALL |
| 9:30 – 9:35 | Welcome Remarks from the Fulbright Commission | Dr. Laurie Ann Vasily |
| 9:35 – 9:40 | Welcome Remarks from the World Bank | Dr. Bill Young |
| 9:40 – 9:45 | Welcome Remarks from ICIMOD | Dr. David Molden |
| 9:45 – 9:55 | Welcome Remarks from NWCF | Mr. Dipak Gyawali |
| 9:55 – 10:10 | Special Remarks | Ms. Cheryl Colopy |
| 10:10 – 10:40 | Keynote Address | Professor Christopher Scott |
| 10:40 – 10:50 | Workshop Logistics | Dr. Laurie Ann Vasily |
| 10:50 – 11:00 | Special Address | U.S. Ambassador to Nepal, Peter W. Bodde |
| 11:00 – 11:15 | Tea Break | |
| | **The Water, Energy, Food Nexus through a Physical Lens**<br>Chair: **Professor Christopher Scott** | SUMERU HALL |
| 11:15 – 11:45 | Presentation: Nexus Aspects of the Ganges River Basin | Dr. Bill Young |
| 11:45 – 12:15 | Presentation: System Modeling of the Water-Energy-Food Nexus in the Indus and the Brahmaputra Basins | Professor Ethan Yang |
| 12:15 – 13:00 | Moderated Discussion and Question & Answer | |
| 13:00 – 14:00 | Lunch Break | SUMERU RESTAURANT |
| | Group Activity: **River Basin Nexus Modeling ("IWRM App")**<br>Facilitator: **Dr N. Harshadeep** | SUMERU HALL |
| 14:00 – 14:30 | Introduction to BasinIT Exercise & 'Spatial Agent' APP | Dr. N. Harshadeep |
| 14:30 – 15:30 | BasinIT Group Work | Group Activity |
| 15:30 – 16:00 | Report back on Group Work | Dr. Bill Young & Groups/Dr. N. Harshadeep |
| 16:00 – 16:30 | Tea Break | |
| | Group Activity: **River Basin Nexus Modeling ("IWRM App")**<br>Chair: **Professor Christopher Scott** | SUMERU HALL |
| 16:30 – 18:00 | Moderated Panel Discussion: River Basin Perspective on the Nexus | Professor Christopher Scott |
| 18:00 – 18:10 | Group Photo | |
| 19:00 – 21:00 | Cultural Show & Dinner | VAIJAYANTA HALL |

## DAY 2 February 11, 2015

| | | |
|---|---|---|
| | **The Water, Energy, Food Nexus through a Social Lens**<br>Chair: **Dr Eklabya Sharma** | **SUMERU HALL** |
| 9:30 – 10:00 | Keynote Address | Dr. Aditi Mukherji |
| 10:00 – 10:45 | Panel Discussion | Dr. Eklabya Sharma |
| 10:45 – 11:15 | Tea Break | |
| | **The Water, Energy, Food Nexus through a Social Lens**<br>Chair: **Dr Eklabya Sharma** | **SUMERU HALL** |
| 11:15 – 12:00 | Interactive Dialogue Café | Dr. Philippus Wester & Dr. Anjal Prakash |
| 12:00 – 12:30 | Plenary Wrap-Up | Dr. Philippus Wester & Dr. Anjal Prakash |
| 12:30 – 13:30 | Lunch Break | SUMERU RESTAURANT |
| | **ICIMOD Visit** | **ICIMOD** |
| 13:30 | Meet in Godavari Village Resort lobby to board vehicles | |
| 13:45 | Arrive at ICIMOD Knowledge Park | |
| 13:45 – 15:45 | ICIMOD Knowledge Park Tour | ICIMOD Knowledge Park Staff Guides |
| 15:45 | Board vehicles to ICIMOD Headquarters | |
| 16:30 – 17:30 | Briefing at ICIMOD Headquarters | Lead by ICIMOD |
| 17:30 – 19:30 | Reception and Dinner at ICIMOD Headquarters | ICIMOD |

## DAY 3 February 12, 2015

| | | |
|---|---|---|
| | **The Water, Energy, Food Nexus through an Institutional Lens**<br>Chair: **Mr Ishwori Prasad Paudyal** | **SUMERU HALL** |
| 9:30 – 9:45 | Keynote Address | Mr. Dipak Gyawali |
| 9:45 – 10:30 | Panel Discussion: How Do Governments Use - or Not Use - the WEF Nexus Approach and Why? | Ms. Cheryl Colopy |
| 10:30 – 10:50 | Question & Answer: Plenary | Ms. Cheryl Colopy |
| 10:50 – 11:00 | Concluding Remarks | Mr. Ishwori Prasad Paudyal |
| 11:00 – 11:15 | Tea Break | |
| | **The Water, Energy, Food Nexus through an Institutional Lens** | **SUMERU HALL** |
| 11:15 – 12:00 | Group Discussion: How Can Research or Action Programs from the Academic, NGO and Private Sectors Support Government Use of the WEF Approach? | Ms. Cheryl Colopy |
| 12:00 – 12:30 | Question & Answer: Plenary | Ms. Cheryl Colopy |
| 12:30 – 13:30 | Lunch Break | SUMERU RESTAURANT |
| | **FINAL SESSION**<br>Chair: **Ms Cheryl Colopy** | **SUMERU HALL** |
| 13:30 – 15:00 | Plenary Discussion of Various Track II Water Dialogues and Discussion of Regional Water Programs | Dr. Undala Alam & Dr. John Dore |
| 15:00 – 15:10 | Special Remarks | U.S. Deputy Assistant Secretary of State, Ms. Fatema Z. Sumar |
| 15:10 - 15:55 | Workshop Wrap up and Plenary Discussion of the Way Forward | Dr. Bill Young, Dr. Phillipus Wester & Mr. Dipak Gyawali |
| 15:55 - 16:00 | Vote of Thanks | Dr. Laurie Ann Vasily |
| 16:00 – 16:30 | Tea Break | |

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## Annex IV: **Day I Presentation by Professor Christopher Scott**

# Water-Energy-Food Nexus

## *Vicious or Virtuous Cycle?*

Christopher A. Scott
University of Arizona
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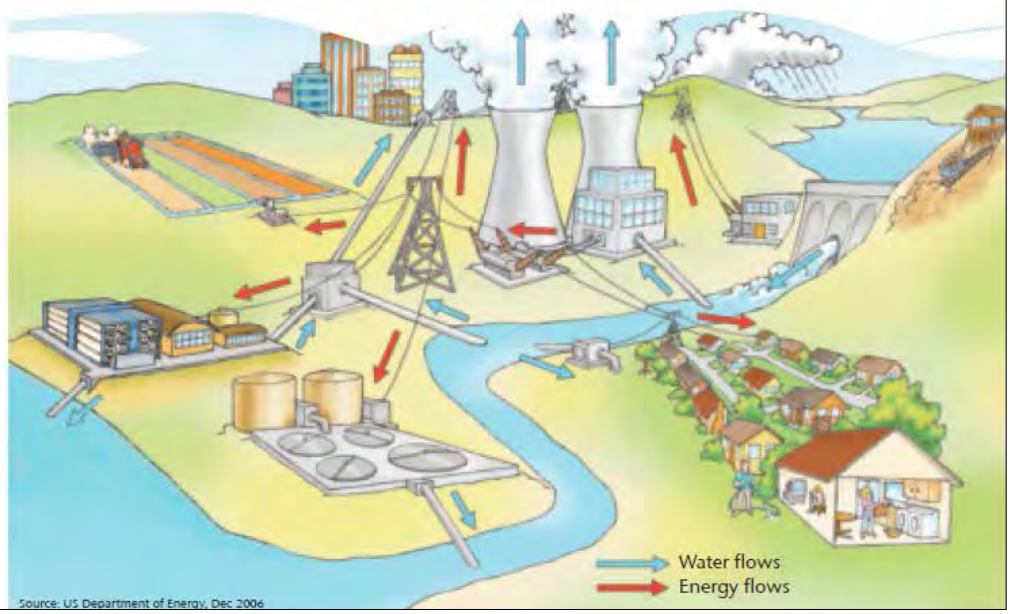
## What is the nexus?

- Water, energy and food (WEF) – essential for quality of life
- WEF mutually interdependent, for example:
  - Irrigation – key for food security
  - Hydropower – for energy security
  - Sustainable farms and cities – water security
- Resource nexus – crucial for societal well-being and prosperity
- Social & political processes + institutions & policies – regulate & manage resources
- Security – seen in human, environmental terms **and** national security terms

# WEF mutual interdependence




# What is internal to the nexus? What is external, contextual?

- Climate?
- Environment?
- Governance?

## The Nexus in 2015

- Shift in global thinking towards sustainable futures
  - Human well-being
  - Resilient ecosystems
  - Co-exist within planetary boundaries
- This is imperative, a matter of survival
- Sustainable Development Goals (SDGs) in 2015 now supplant target-oriented Millennium Development Goals (MDGs)

## The Nexus - A genealogy

- Early scientific references to the "nexus"
  - cell biology (complex electro-chemical-tissue interlinkages
  - economics (mutual wage-price-labor dependencies)
  - institutional literature (contracts among tiered firms)
- "Nexus" of resources
  - 1983 UNU Food-Energy Nexus Programme
    - Food, Energy, and Ecosystems Conference - Brasilia, 1984
    - Second International Symposium on the Food-Energy Nexus and Ecosystems - New Delhi, 1986
  - Mid-1980s Western United States water for electricity concerns (later dubbed a "nexus")

# The W-E nexus in agriculture

- Mid-to-late 1990s - early 2000s: India W-E-Agriculture "Nexus"
  - Green Revolution natural resource and socio-economic impacts became increasingly severe, no longer "externalities"
  - Sant and Dixit (1996) addressed energy supply for groundwater pumping
  - Padmanaban and Sarkar (2001) and Malik (2002) identified the groundwater-electricity nexus
  - Shah, Scott et al (2003, 2007) ag sector/ utility scale
  - Kumar (2004), Mukherji (2005) economics of nexus
  - WENEXA project (USAID) operational in Karnataka
  - Mexico, virtual water (Scott 2004; Scott & Shah, 2004)

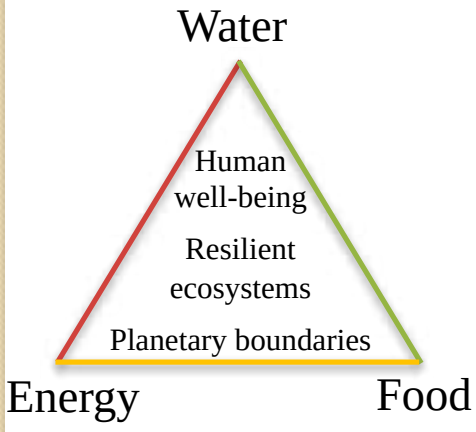
# Water-Energy-Food Nexus

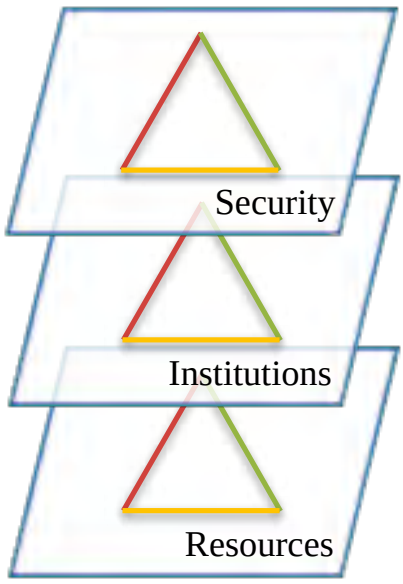
- 2006 Hyderabad workshop – IWMI, ICRISAT, Wageningen Univ., others
  - Hellegers et al (2008)
  - Siegfried et al (2008)
- WEF Nexus in climate adaptation (Lopez-Gunn 2009)
- Resource dependencies (Lazarus 2010)
- Climate-demographic coupled drivers (Scott 2011)
- WEF Nexus became further institutionalized
  - Bonn2011 (Hoff 2011)
  - Stockholm (multiple years, 2014)
- Dresden, UNU-FLORES, 2013, 2015 and beyond

# Resources, society, institutions

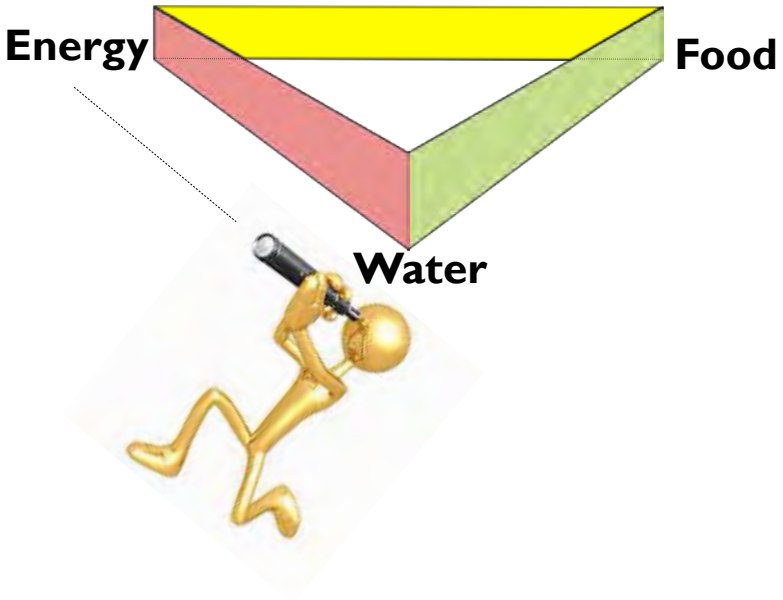
- Nexus links resource-use practices, previously considered in isolation
- Resource efficiency gains
  - Beware, "savings" lead to increased use
  - Jevons' Paradox (*The Coal Question,* 1865)
  - Rebound (take-back) effect
- Policy articulation is key to operationalizing the nexus
  - Security of resource access
  - Equity – socioeconomic and intergenerational

# Water, energy, food: multi-scale interactions



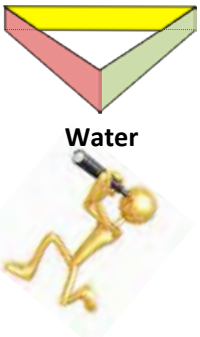
# The Opticon: W-E-F mutual perspectives vary




# The water perspective on energy and food challenges

**Energy** challenges from **water** perspective:

- Water footprint of multiple energy portfolios
- Energy generation degrades water quality
- Dry cooled thermo-generation potential/ limits
- Low water footprint solar PV and wind



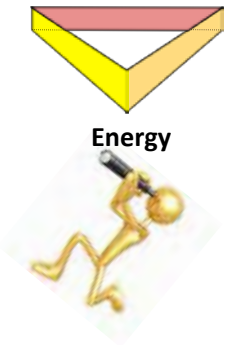

**Food** challenges from **water** perspective:

- Production shifts poleward, higher elevation
- Climate change raises irrigation demand
- More groundwater pumped w/variable climate
- Diminishing institutional influence of irrigation

# The energy perspective on food and water challenges

**Food** challenges from **energy** perspective:

- Local food chains minimize transport energy
- Energy intensity of farm operations
- Climate change increases food cooling needs
- Extended crop seasons, night-time operation



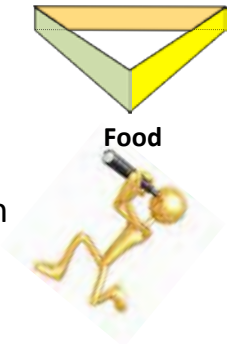

**Water** challenges from **energy** perspective:

- Climate change raises water needs of energy
- Ensure water allocation to energy generation
- Rising demand for carbon-free hydropower
- Energy intensity of desalination, water reuse

# The food perspective on water and energy challenges

**Water** challenges from **food** perspective:

- High water footprint of agriculture
- Ensure water allocation to irrigation
- Supplemental irrigation of rainfed land
- Water, land degradation (e.g., salinization)
- Wastewater use for food production




**Energy** challenges from **food** perspective:

- Biofuel must not compete w/ food production
- Energy intensification of agriculture
- Energy intensification of food transport
- Mitigate hydropower-farming tradeoffs

## Key questions

- How are mutual WEF interlinkages expressed in resource, institutional and security terms?
- Which interdisciplinary approaches can pose challenges and solutions drawn from the Tri-Opticon figures?

## Case examples

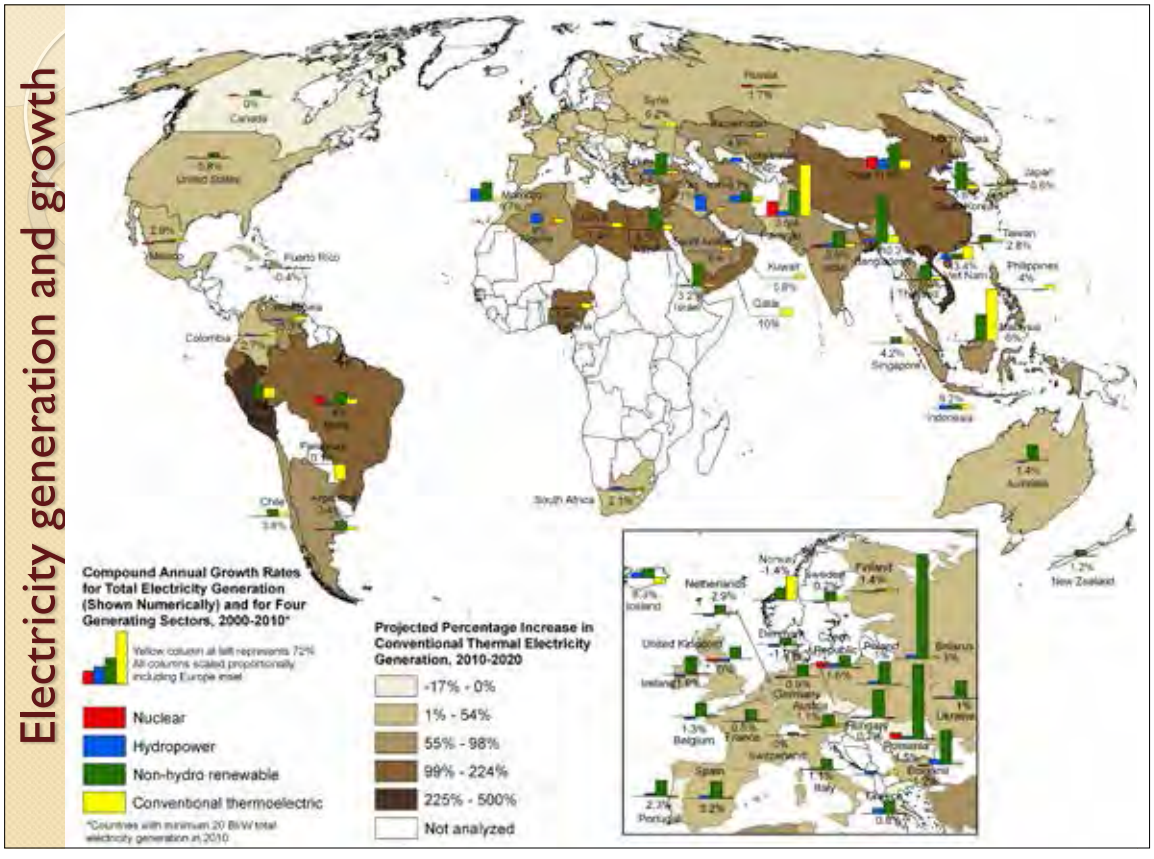
1. Global energy development and water scarcity
   - Food-security implications of irrigation reallocation, expansion of biofuels
2. Groundwater-electricity-food nexus (India and Mexico examples)

- In brief:

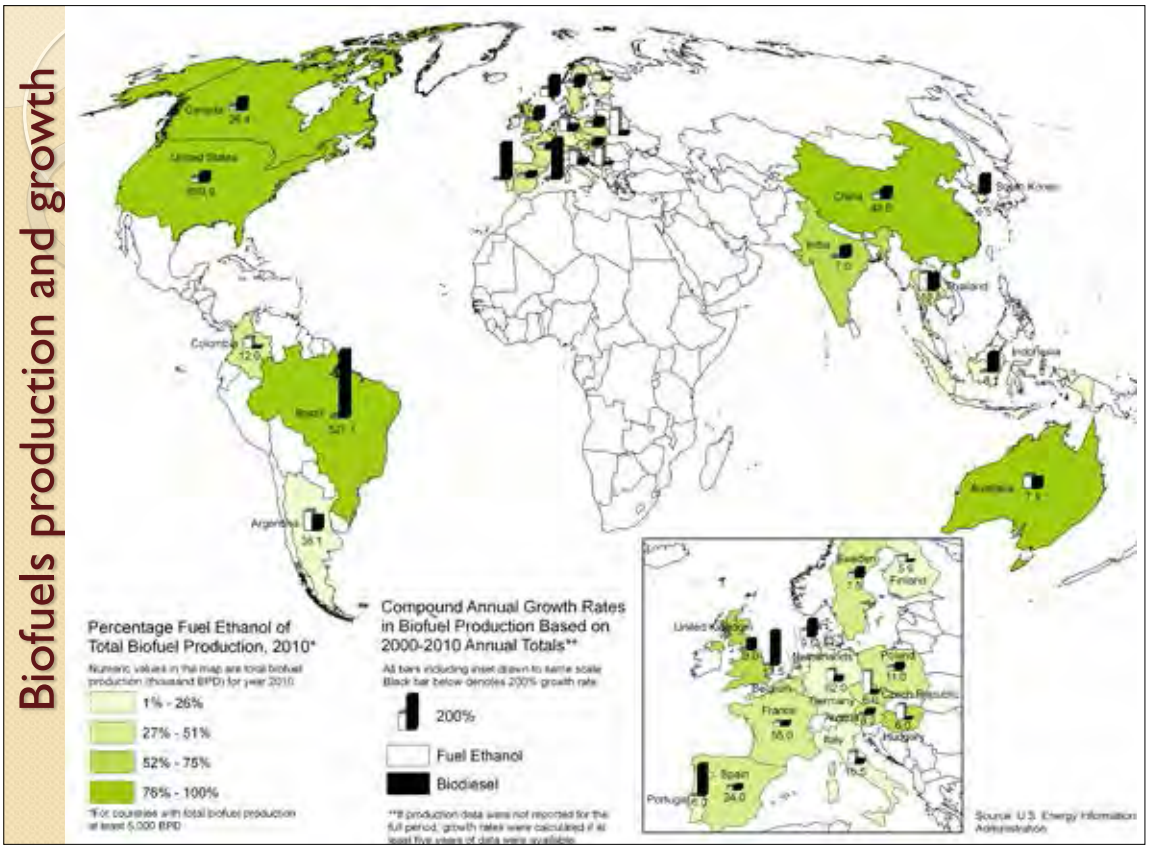
3. Desalination – Arizona, Southwest US, and transboundary US-Mexico cases
4. Hydropower-irrigation nexus (Uttarakhand, India) new project

# Global energy development and water scarcity

- Consider water availability
  - physical limits, allocations
  - water-for-energy – global spatial & temporal trends
- Greatest water-quantity impacts
  - electrical power generation
  - biofuel – irrigation and lifecycle assessments
- Data
  - US Energy Information Administration
  - UN FAO AQUASTAT



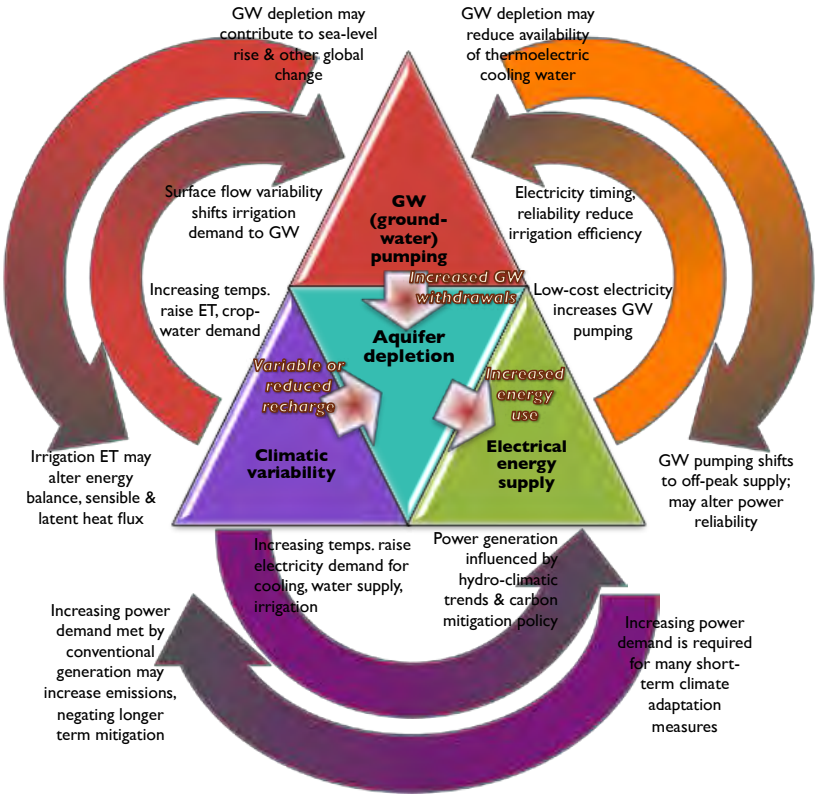
## Biofuels production and growth




# Flashpoints

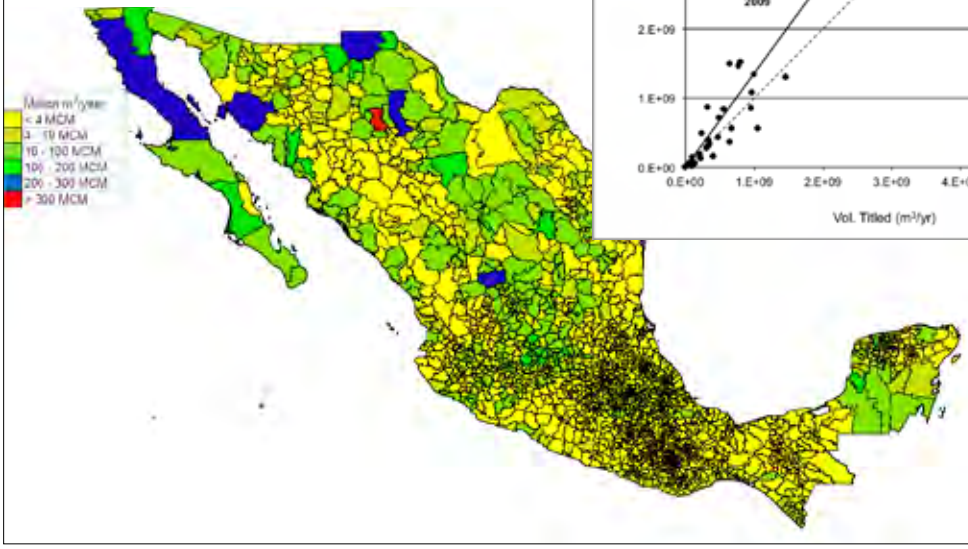
- Energy-related physical water scarcity
  - Middle East
  - Small-island states
- Sectoral limits (reallocate increasingly scarce, rights-appropriated, ecological-flow water)
  - Brazil
  - India
  - China
  - USA
  - others

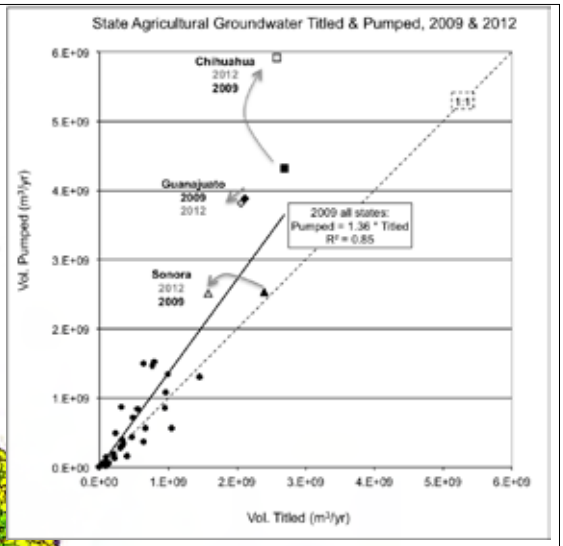
# Groundwater-Electricity-Food Nexus




## Regulation unsuccessful

Drilling bans (*vedas*) and concession titles alone are inadequate; pumped GW exceeds titled GW

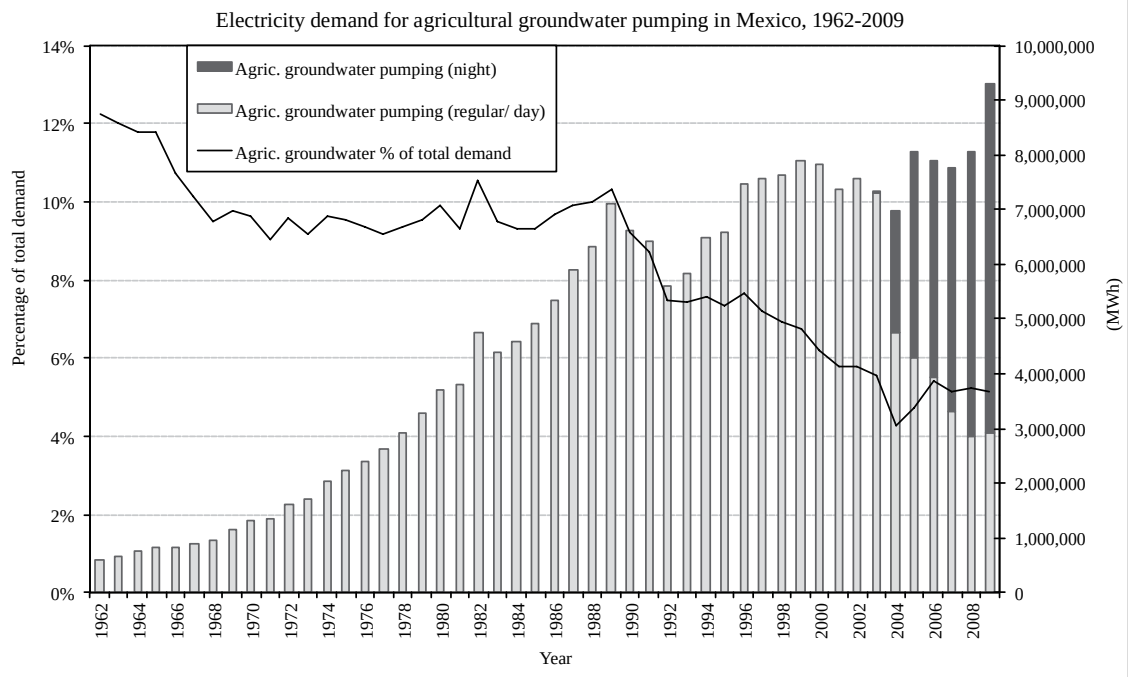




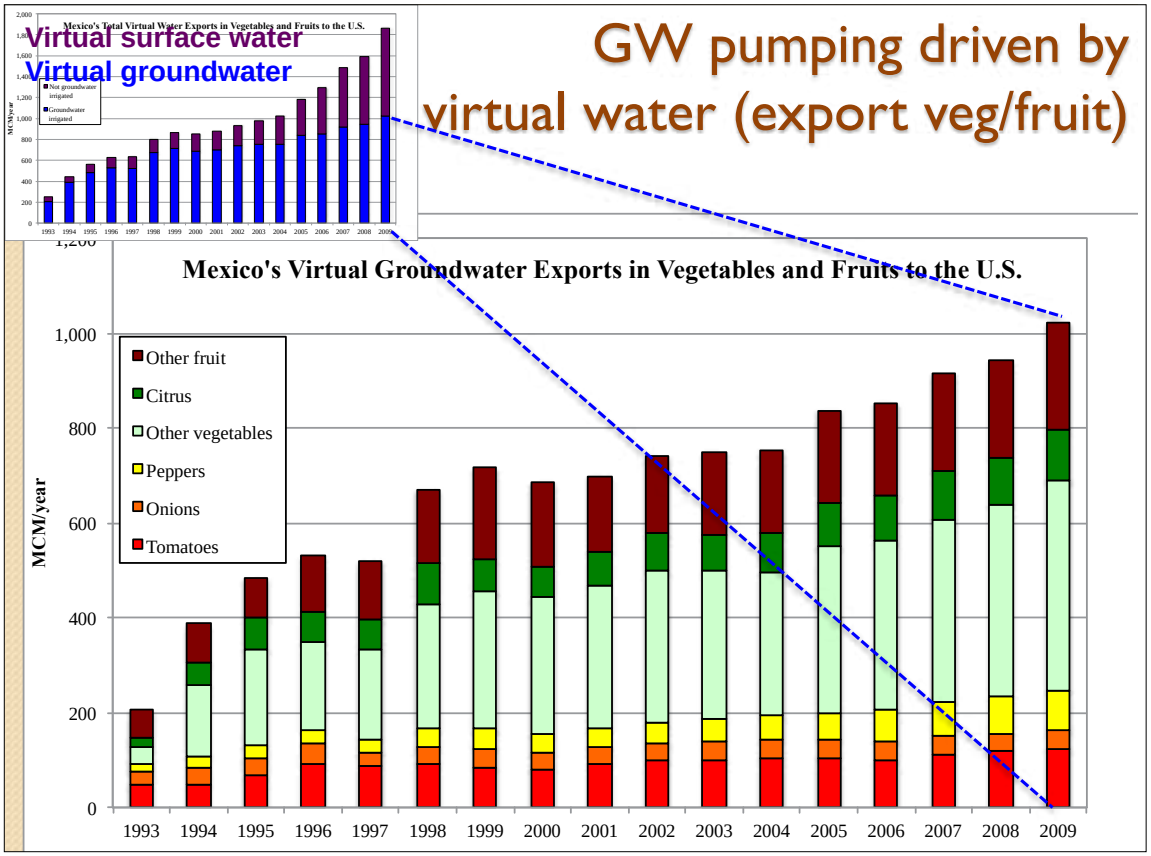
# Legal and regulatory approaches must focus on the nexus

- *Ley de Energía para el Campo* (2002) a good attempt, but strongly opposed
  - *Límite de energía anual* based on concessioned volume
  - This ***nexus-based regulation*** was supplanted in 2003 by night-time *tarifa 9N* (50% day-time rate)
  - 2006 farmers secured a Mex$ 0.10 per kWh subsidy on daytime tariffs (SAGARPA, Mex$ 686 million = US$ 62 million)

# Agricultural power sales in Mexico



# GW pumping driven by virtual water (export veg/fruit)



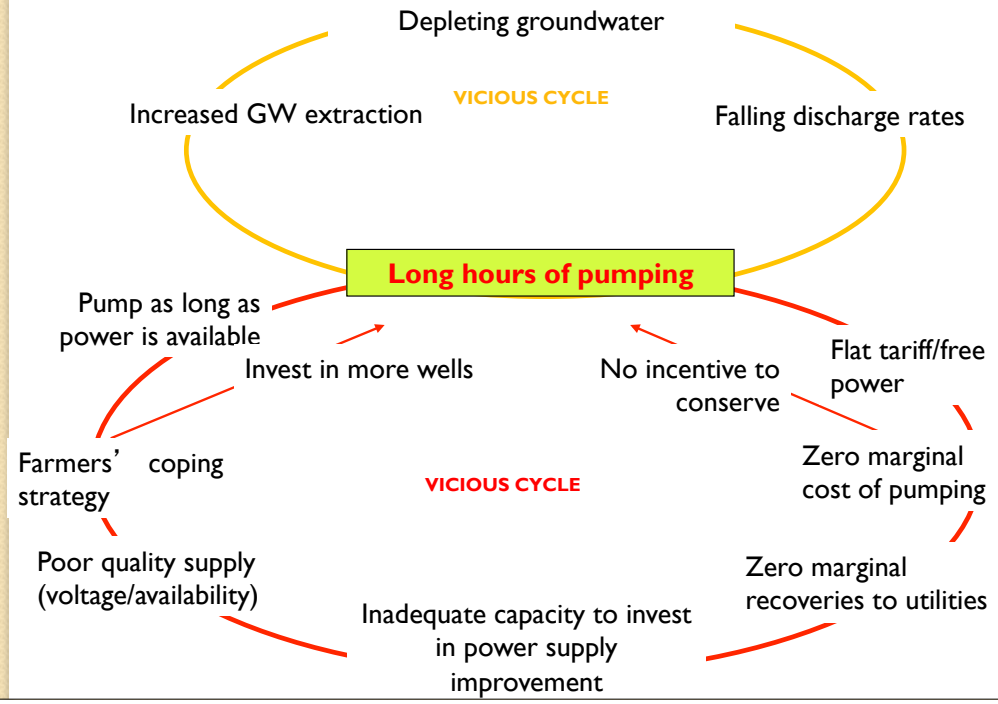

# CONAGUA – National Water Commission
# CFE – Federal Electricity Commission

- Contentious rivalry must move to collaborative relationship
- Need extensive data sharing for informed decision-making
- Water demand for power generation will only increase
- Hydropower – another nexus opportunity lost

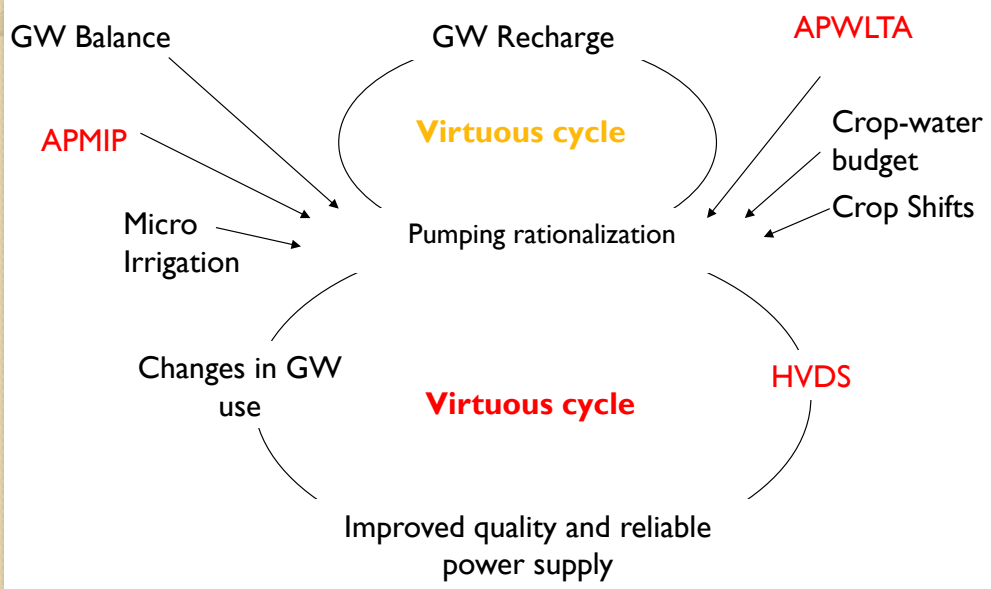
# Groundwater users self-regulation COTAS

- Groundwater technical committees
- CONAGUA model
  - coordination platform centered on federal authority
- Guanajuato state model
  - IWRM but without legal mandate
  - Lack incentive mechanisms
- P. Wester publications

# Deccan India: Vicious nexus cycle



# Andhra Pradesh: virtuous-cycle opportunities

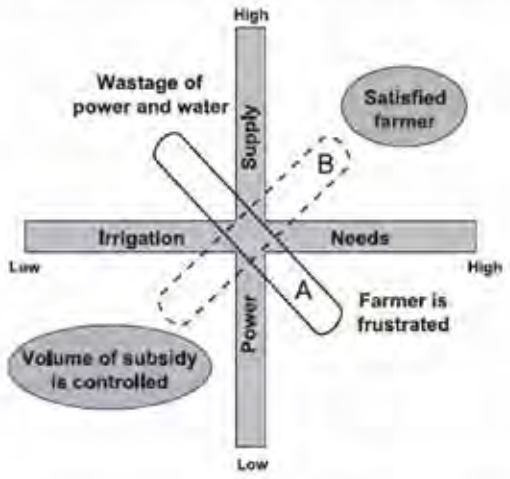



# Groundwater-electricity-food

- Groundwater as strategic resource/ reserve, *or*
- Groundwater depletion – can this be planned? Is it politically, socially, environmentally viable?
- Intergenerational equity rises above sectoral, spatial, or transboundary equity
- Virtual water arguments fall flat when based on overdrafted groundwater
- Current trajectory towards depletion has impacts for the future of agriculture

# Power supply and tariff regimes

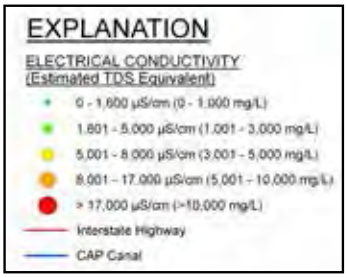
FIGURE 7:
Improving farmer satisfaction and controlling subsidies for electricity through intelligent management of the farm power supply

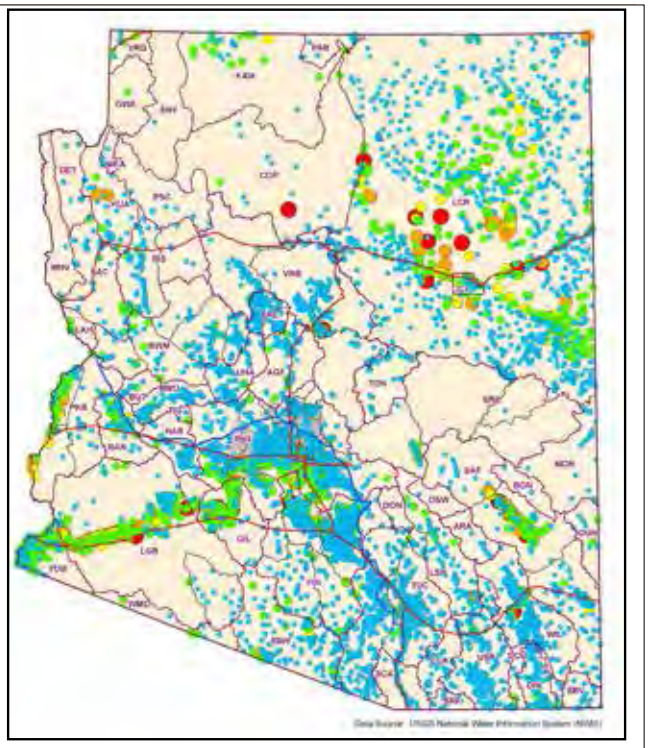



A Mismatch between power supply and irrigation needs; existing system in which the farmer is frustrated.

B A win-win scenario: power supply is good and reliable when the irrigation needs are high (satisfied farmer), and power supply is low when irrigation needs are low (volume of subsidy is controlled).

# Arizona desalination: "next bucket" or pipe dreams?



Errol L. Montgomery & Associates, Inc.

CAP CENTRAL ARIZONA PROJECT

# Desal cross-border transfers or swap for Colorado river water


# Irrigation-hydropower nexus in upper Ganges headwaters

# Irrigation-hydropower nexus (HI-NEX) project

- Objectives:
  - Develop the knowledge base on interconnections among water, energy, and food in upper Ganges basin
  - Identify institutional and policy opportunities, obstacles to harness irrigation-hydel nexus for livelihood resilience
  - Identify opportunities to pilot water, energy, and food systems development led by women and youth.

- Project team:
  - University of Arizona
  - Kumaun University – Nainital
  - People's Science Institute – Dehradun
  - University of Delhi
  - ICIMOD
  - Integrated Mountain Initiative – New Delhi

# Conclusions

- WEF nexus expressed in multiple domains
  - Resources
  - Society, institutions
  - Security
- WEF – perils of vicious-cycle traps, yet multiple options for virtuous-cycle adaptive solutions

# Thank you


- Fulbright Commission and State Dept. for invitation
- ICIMOD/HI-AWARE for support
- SAWI and NWCF for collaboration

# Christopher Scott

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## See selected WEF nexus publications

http://aquasec.org/wrpg/publications/#nexus


Scott, C.A., A. Crootof, S. Kelly-Richards. In review. The urban water-energy nexus: Drivers and responses to global change in the 'urban century'. United Nations University and Springer.

Scott, C.A., M. Kurian, J.L. Wescoat, Jr. 2015. The Water-energy-food nexus: Adaptive capacity to complex global challenges. In M. Kurian and R. Ardakanian (eds.). *Governing the Nexus: Water, Soil and Waste Resources Considering Global Change*, Springer, Berlin, pp. 15-38.

Scott, C.A. 2014. Eletricidade para o bombeamento de água subterrânea: limitações e oportunidades para respostas adaptativas às mudanças climáticas. *Desenvolvimento e Meio Ambiente* 30: pp.

Andersen, S.M., C.A. Scott (special-issue co-editors). 2014. Nexo Água e Energia nas Américas (Water-Energy Nexus in the Americas). *Desenvolvimento e Meio Ambiente* (Development and Environment) 30: pp. (Portuguese, Spanish, and English special issue, Universidade Federal do Paraná, Brazil. http://ojs.c3sl.ufpr.br/ojs2/index.php/made).

Scott, C.A. 2013. Electricity for groundwater use: constraints and opportunities for adaptive response to climate change. *Environmental Research Letters* 8 (2013) 035005, doi: 10.1088/1748-9326/8/3/035005.

Kumar, M.D., C.A. Scott, O.P. Singh. 2013. Can India raise agricultural productivity while reducing groundwater and energy use? *Int'l J. Water Resources Development*, doi:10.1080/07900627.2012.743957

Scott, C.A. 2011. The water-energy-climate nexus: resources and policy outlook for aquifers in Mexico. *Water Resources Research* 47, W00L04, doi:10.1029/2011WR010805.

Scott, C.A., S.A. Pierce, M.J. Pasqualetti, A.L. Jones, B.E. Montz, J.H. Hoover. 2011. Policy and institutional dimensions of the water-energy nexus. *Energy Policy* 39: 6622–6630

Scott, C.A., M.J. Pasqualetti. 2010. Energy and water resources scarcity: Critical infrastructure for growth and economic development in Arizona and Sonora. *Natural Resources Journal* 50(3): 645-682.

# Annex V: **Day 1 Presentation by Dr Bill Young**



## Water-Energy-Food Nexus

The Ganges River Basin

Bill Young, Lead Water Resources Management Specialist

10 February 2015

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Water

FULBRIGHT
WATER-ENERGY-FOOD NEXUS
REGIONAL WORKSHOP

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## Presentation Outline

- The Ganges Basin
  - A brief introduction
- Current Status of Water Resources Development
  - Agriculture, hydropower, groundwater pumping
  - Nexus issues and the need for decoupling
- River Basin Planning to Manage the Nexus
  - Concepts and requirements
  - World Bank support in the basin

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# The Ganges Basin

## A brief introduction

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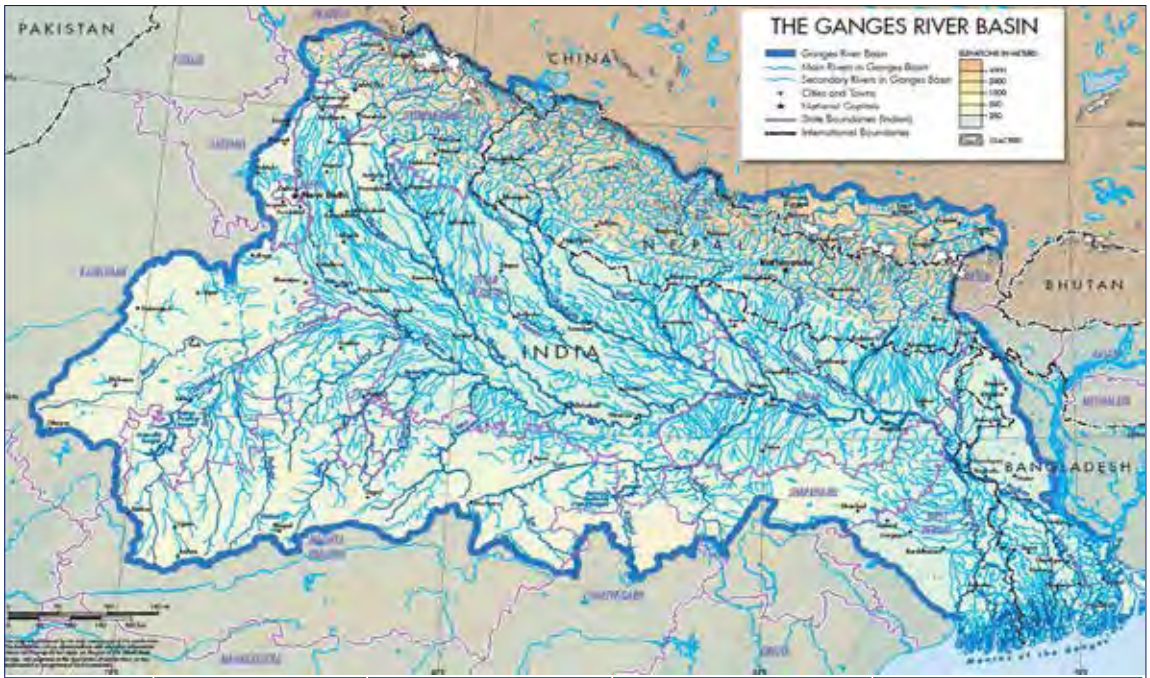
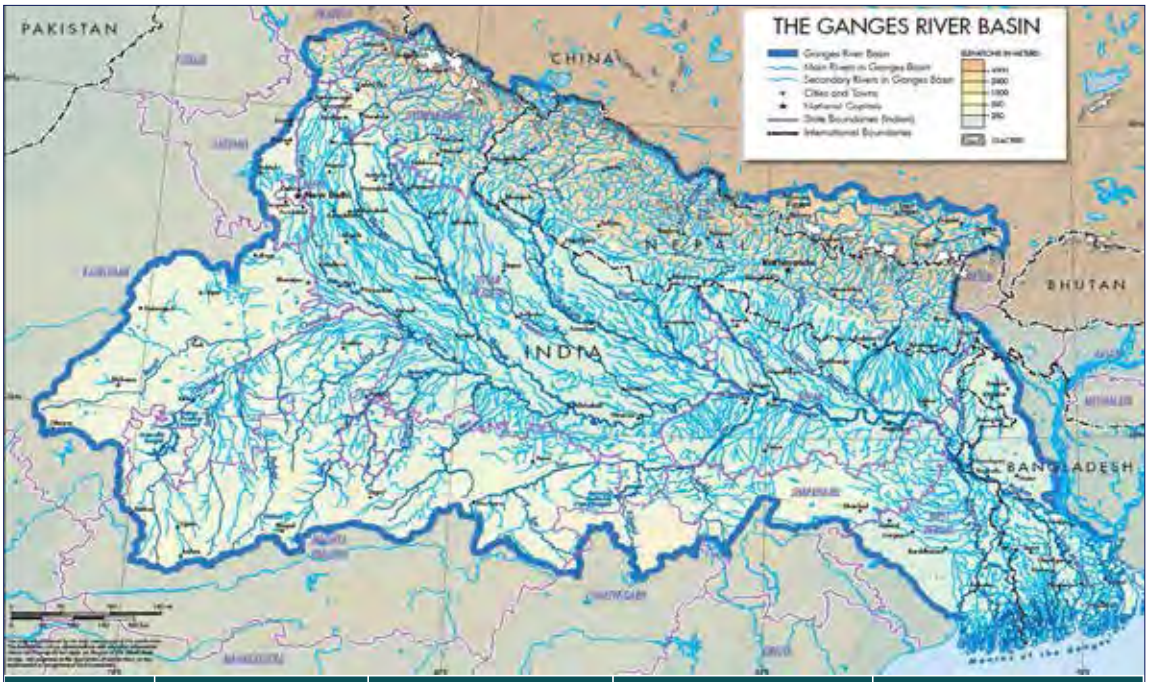
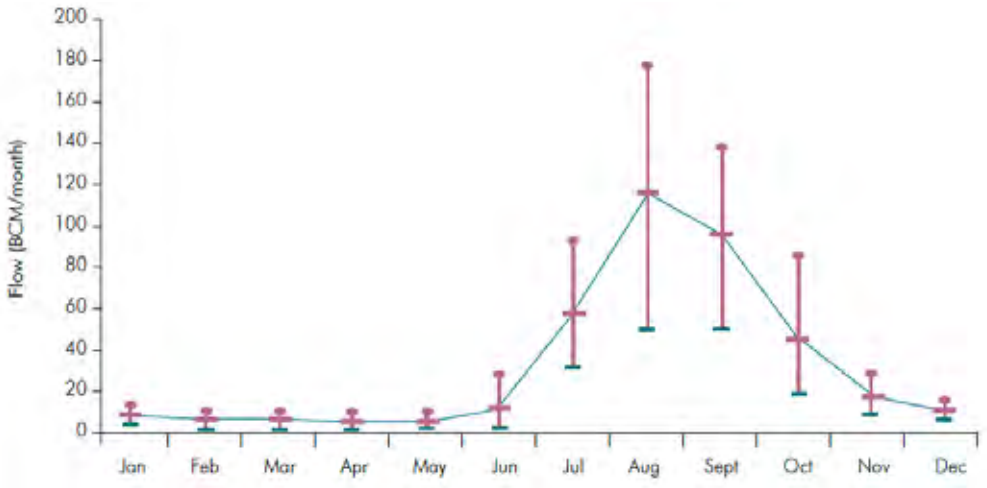



| | % of Basin Area | % of Basin Population | % of Basin Streamflow | % of Basin HEP Potential |
|---|---|---|---|---|
| Nepal | 12 | 4 | 28 | 66 |
| India | 84 | 88 | 68 | 34 |
| Bangladesh | 3 | 8 | ~0 | 0 |




| | % of Country Area | % of Country Population | % of Country Streamflow | % of Country HEP Potential |
|---|---|---|---|---|
| **Nepal** | 100 | 100 | 100 | 100 |
| **India** | 31 | 47 | 28 | 14 |
| **Bangladesh** | 27 | 38 | 40 | 0 |

## Monsoon Flow Regime

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# Basin Water Resources

Irrigation, Hydropower, Groundwater pumping, Nexus issues and Decoupling

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# The Water Resource (Annual Averages)

- China
  - Generates around 22 BC streamflow
  - Little or no demand
- Nepal
  - Generates around 148 BCM streamflow, 11 BCM GW
  - Demand is around 10 BCM SW, 1 BCM GW
- India
  - Generates around 355 BCM streamflow, 179 BCM GW
  - Demand is around 215 BCM SW and 102 BCM GW
- Bangladesh
  - Generates 165 BCM streamflow (river attribution difficult), 65 BCM GW
  - Demand is around 10 BCM SW, 29 BCM GW

| | Storage (BCM) |
|---|---|
| China | 0 |
| Nepal | <1 |
| India | ~45 |
| Bangladesh | 0 |
| Total | ~46 |

| | SW % Use | GW % Use | Total % Use |
|---|---|---|---|
| China | 0% | 0% | 0% |
| Nepal | 7% | 9% | 7% |
| India | 61% | 57% | 59% |
| Bangladesh | 6% | 45% | 17% |
| Total | 34% | 52% | 39% |

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# Agriculture / Food security in three countries

- Nepal
  - 1 million ha irrigated; >95% of national water use
  - Food deficit: primarily in the mountain regions
  - ~75% of labor force, ~35% of GDP
- India
  - 35 million ha irrigated (2/3 by GW)
  - Over 90% of SW is for irrigation; over half of national water use
  - Agricultural sector is the largest employer, but food deficit basin
  - Low productivity: poor agricultural water management including poor drainage
- Bangladesh
  - 4 million ha irrigated (2/3 by GW) – entire country; Food deficit
  - Low productivity: poor agricultural water management including poor drainage
  - Flood and cyclone vulnerability and saltwater intrusion
  - Irrigation dominated by groundwater pumping
- Food production not really constrained by water availability
  - Water use efficiency is low
  - Productivity (yields) very low… by area and water volume

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## Energy – Hydropower

- Nepal
  - Estimated 40 GW potential; < 1 GW developed (~2%)
  - Winter supply short-fall ~50% of demand
  - Potential far exceeds projected demand: export opportunity
  - 12 grid links with India; most used import; one for export
  - Total exchange ~120 MW
  - 2014 Pancheswar bilateral agreement; 6.5 GW
- India
  - Estimated 21 GW potential; 5.2 GW developed (~25%)
  - 300 million without access to electricity
  - Additional 700 GW required by 2050
- Bangladesh
  - 60 million lack access to electricity
  - One 400 kV link from India recently installed

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## Energy Demands for Water

- Dominated by energy for groundwater pumping
  - 60% electric, 40% diesel
  - ~36 GWh
- Water for cooling for thermal power stations
- Link to inland navigation in order to transport coal to power stations by river


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## India-wide: energy and water

- Total water use 650 BCM
  - 250 BCM from GW
  - 150 BCM via electric pumps – shallow pumping
- 150 BCM GW
  - Uses ~20% of total national electricity demand
  - Efficiency of pumping ~30%
  - Associated carbon emissions are 6% of national total
  - Electric pump emissions 5x higher than diesel pumps
- Hydropower generation
  - ~20% of total generation

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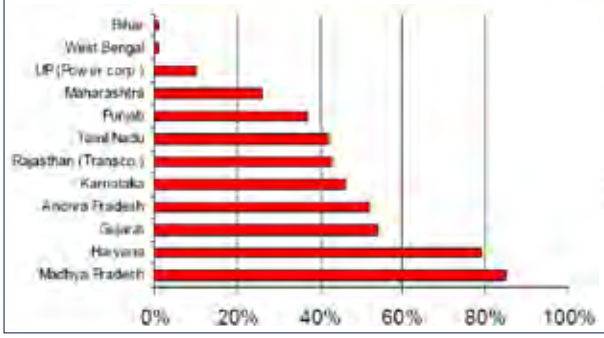
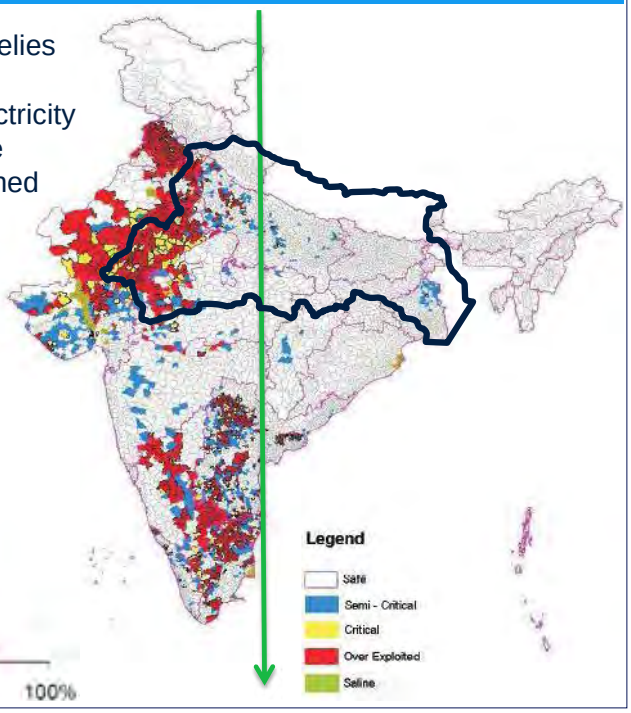
## GW Use and Electricity Subsidies

- 15% of India's food production relies on GW "mining"
- Poorer Eastern region lacks electricity and so reliant on diesel… where
- Rising fuel prices have constrained GW use

**Power subsidies by state**



## Are solar pumps the perfect solution?

- Replace all electric pumps: save US$5B in subsidies
- Overcome unreliable grid supply
  - Change farmer behavior…?
- Sell surplus power into the grid as “cash crop”
  - Reduce GW depletion…?
- Sustainably develop GW in the eastern areas
  - De-couple from rising fuel costs
- How to prevent over-abstraction of GW?
  - Incentives? Regulation?

## Nexus Connections

| Intervention | Energy production | Energy Consumption | Food Production | Food Consumption | Environmental Impact |
|---|---|---|---|---|---|
| New dams | ⇧ | ⇧ | -- | -- | ⇧ |
| Solar pumps | ⇧ | ⇧ | ⇧ | ⇧ | ⇩? |
| Better water management | -- | ⇩ | ⇧ | ⇧ | ⇩ |
| Better energy management | -- | ⇩ | ⇧ | ⇧ | ⇩ |

- Continuing trends of:
  - Population increase, urbanization, economic development, per capita consumption
- Need to decouple
  - Food security from increased water use
  - Economic growth from increased water (and other resource use)
- Growth of the services economy

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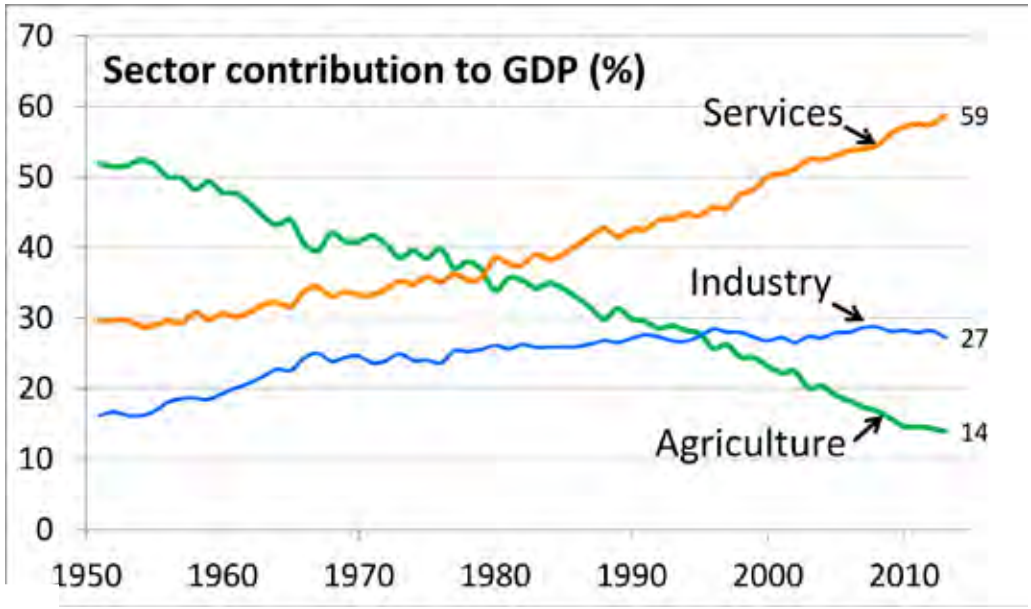
## India – changing sector contributions

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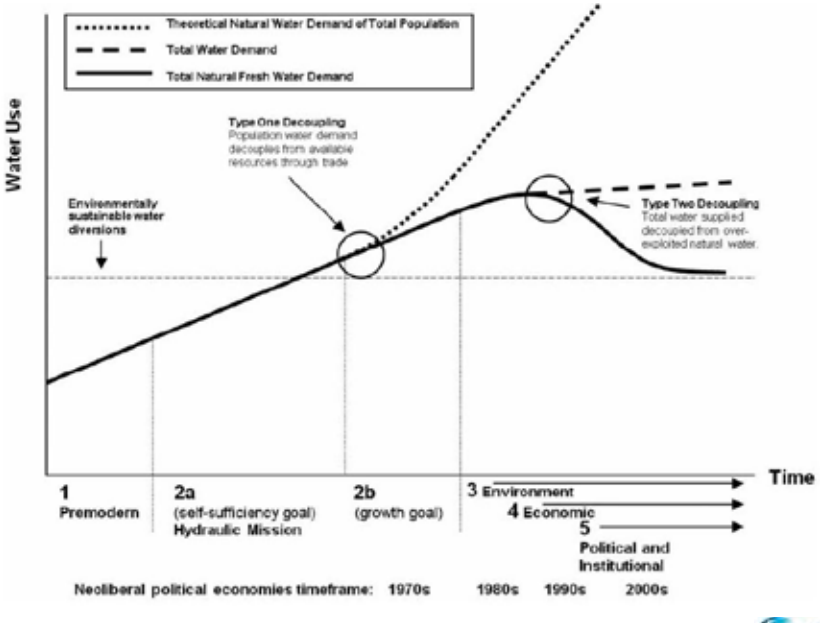
## Decoupling growth from increased water use

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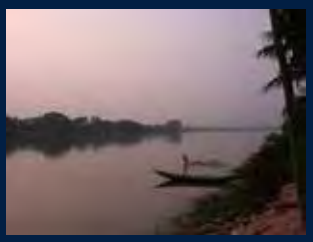
# River Basin Planning

## A mechanism to manage the nexus





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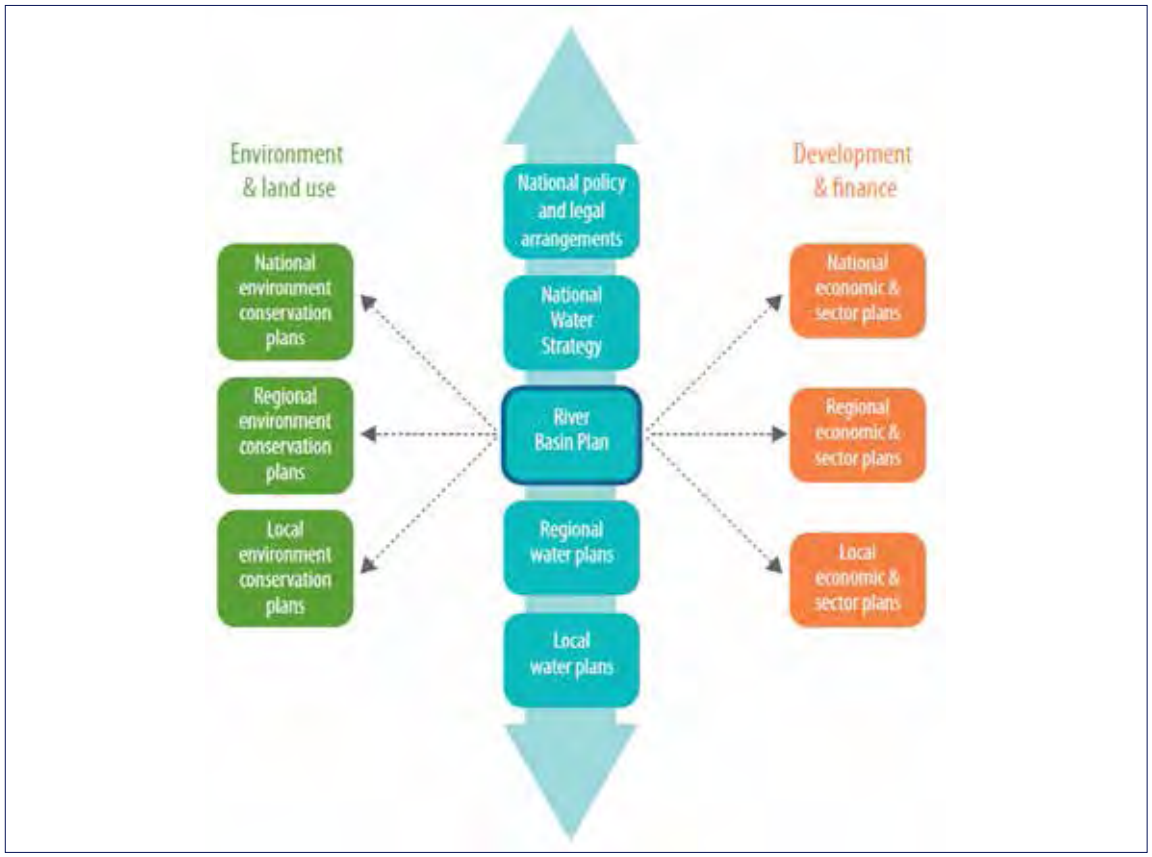
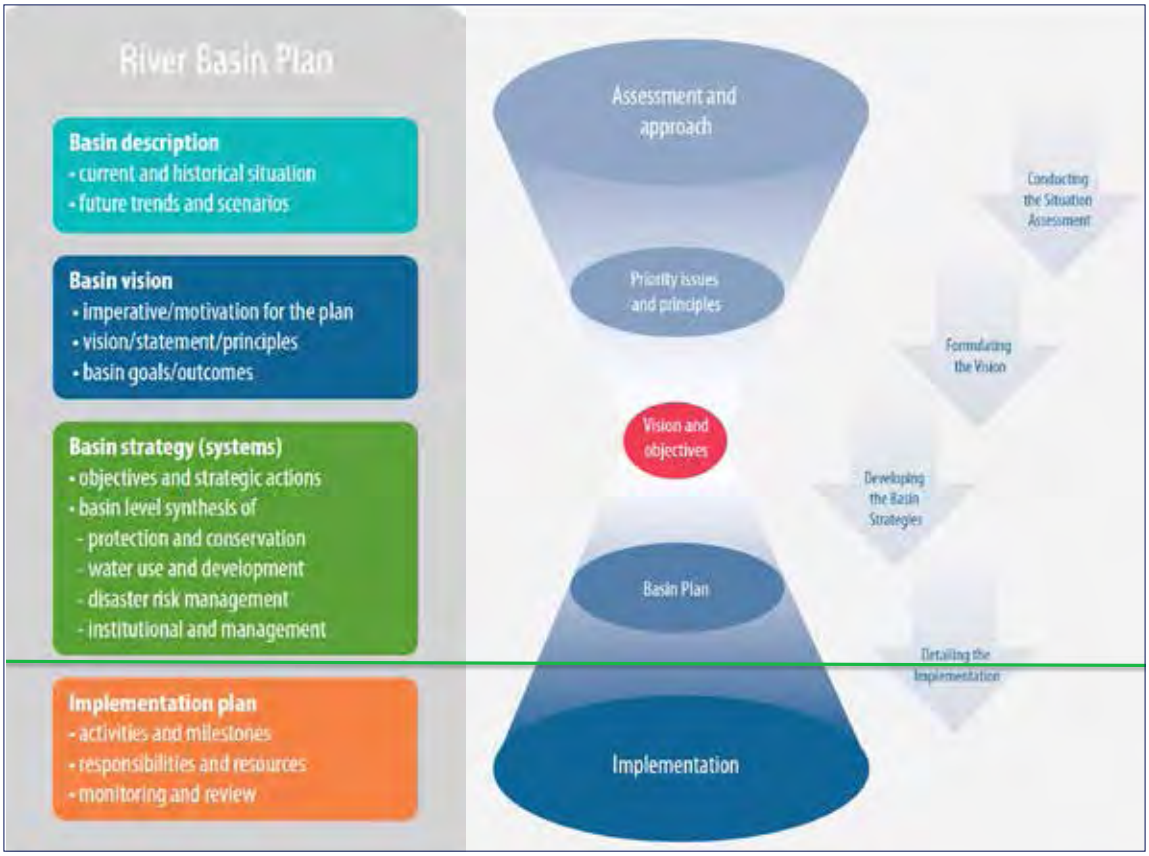
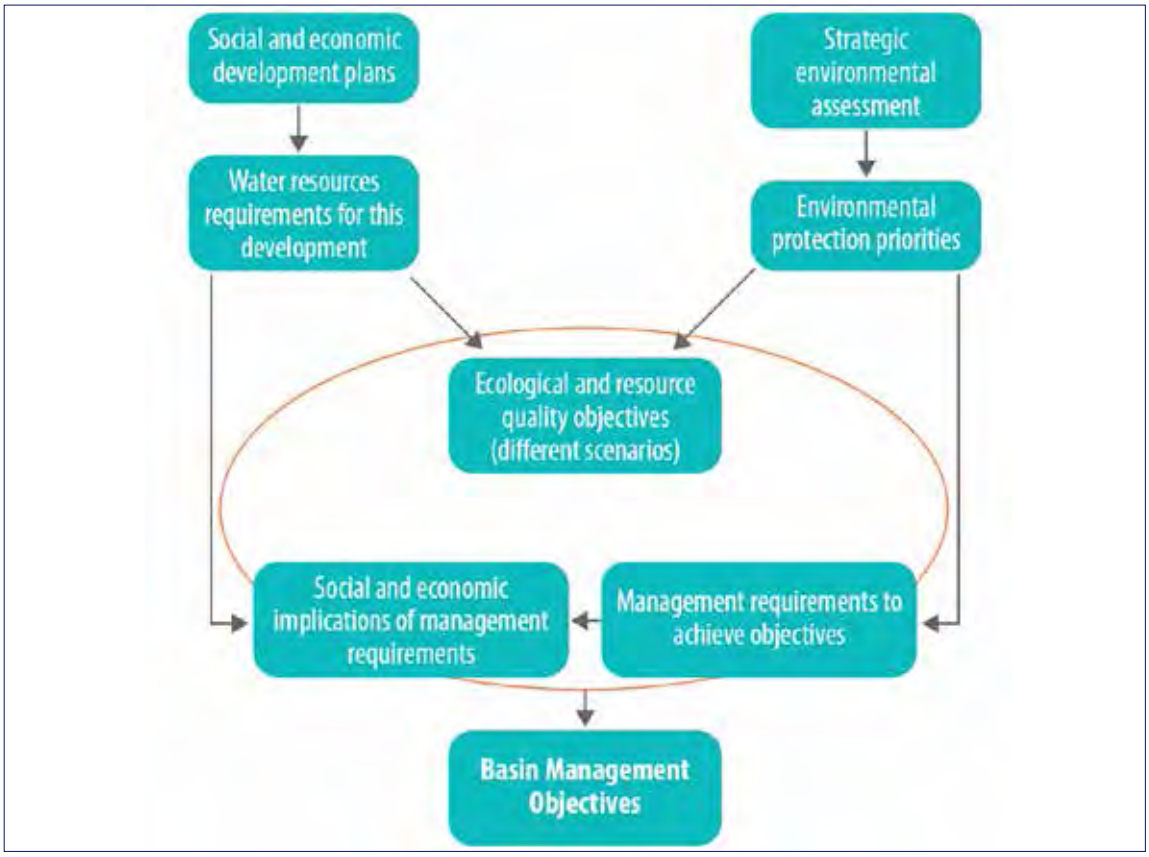
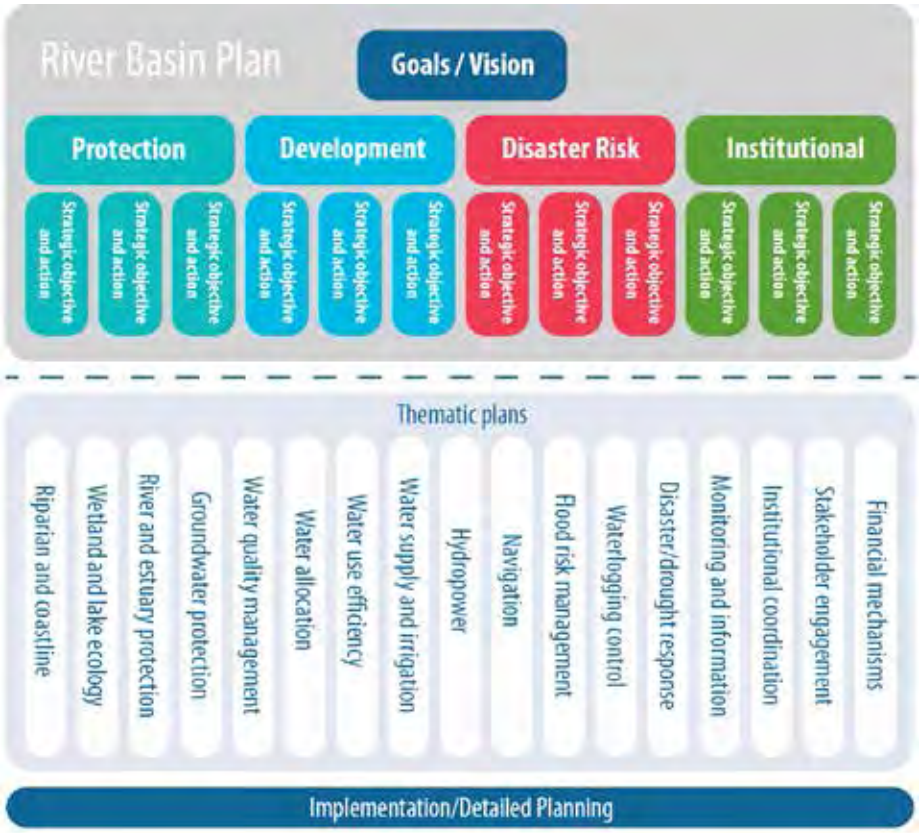
Water




River Basin Plan
Basin description
- current and historical situation
- future trends and scenarios
Basin vision
- imperative/motivation for the plan
- vision/statement/principles
- basin goals/outcomes
Basin strategy (systems)
- objectives and strategic actions
- basin level synthesis of
- protection and conservation
- water use and development
- disaster risk management
- institutional and management
Implementation plan
- activities and milestones
- responsibilities and resources
- monitoring and review
Assessment and approach
Priority issues and principles
Vision and objectives
Basin Plan
Implementation
Conducting the Situation Assessment
Formulating the Vision
Developing the Basin Strategies
Detailing the Implementation


Social and economic development plans
Strategic environmental assessment
Water resources requirements for this development
Environmental protection priorities
Ecological and resource quality objectives (different scenarios)
Social and economic implications of management requirements
Management requirements to achieve objectives
Basin Management Objectives




## What does a strategic basin plan look like?

- Agreed evidence-based description of the problem and/or opportunity being addressed
  - Rehabilitation vs development…
  - Consider the economic, environmental and social dimensions
- A realistic and agreed vision for the future
  - That can be translated into measurable targets
- A prioritized view of the agreed changes / interventions required to achieve the desired outcomes
  - Provide long-term strategic view and commit to short-term action
  - Build on an evidence-base of costs and effectiveness
- Framework for monitoring and evaluation
  - Accountability, review and adaptive learning
- Description of implementation responsibilities & mechanisms
  - Be clear who will do what, on what legal authority and with what resources

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## Fundamental Requirements

- Build a consistent, integrated and open evidence base to describe the system and the problem
- Establish an efficient and coordinated process for stakeholder consultation and engagement
- Be clear on governance arrangements for basin planning and subsequent implementation efforts
- Ensure adequate resourcing (financial, human, institutional) for planning and implementation
- Commit to long-term monitoring of outcomes and adaptive learning

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## World Bank Support for Basin Planning

- Nepal
  - Preparation of IWRM / river basin plans for selected basins including strategic environmental assessments
  - Improvements to regulatory and institutional frameworks for water resources development
- India
  - Strategic basin planning to guide Ganga Rejuvenation
  - Improvements to hydrologic monitoring systems, river modelling and decision support systems
- Regional
  - Community of Practice for river modelling of the Ganges Basin
  - Ganges Basin dialogue process linked to the work of the CoP

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# Nepal River Basin Planning Objectives

- For major river basins in Nepal:
  - Build up the knowledge base
  - Develop the Basin Plan, covering major uses of water such as hydropower, irrigation, drinking water, etc.
  - Ensure sustainability of water resources, and
  - Development capacity for river basin planning and water resources management
- Implementation arrangements
- Coordination Committee across relevant Ministries (WECS, DoED, Irrig, MOSTE..)
- Implementing Agencies
  - WECS – river basin knowledge base, river system modelling
  - Dept. of Irrigation – Irrigation Master Plan
  - DoED – Hydropower Master Plan

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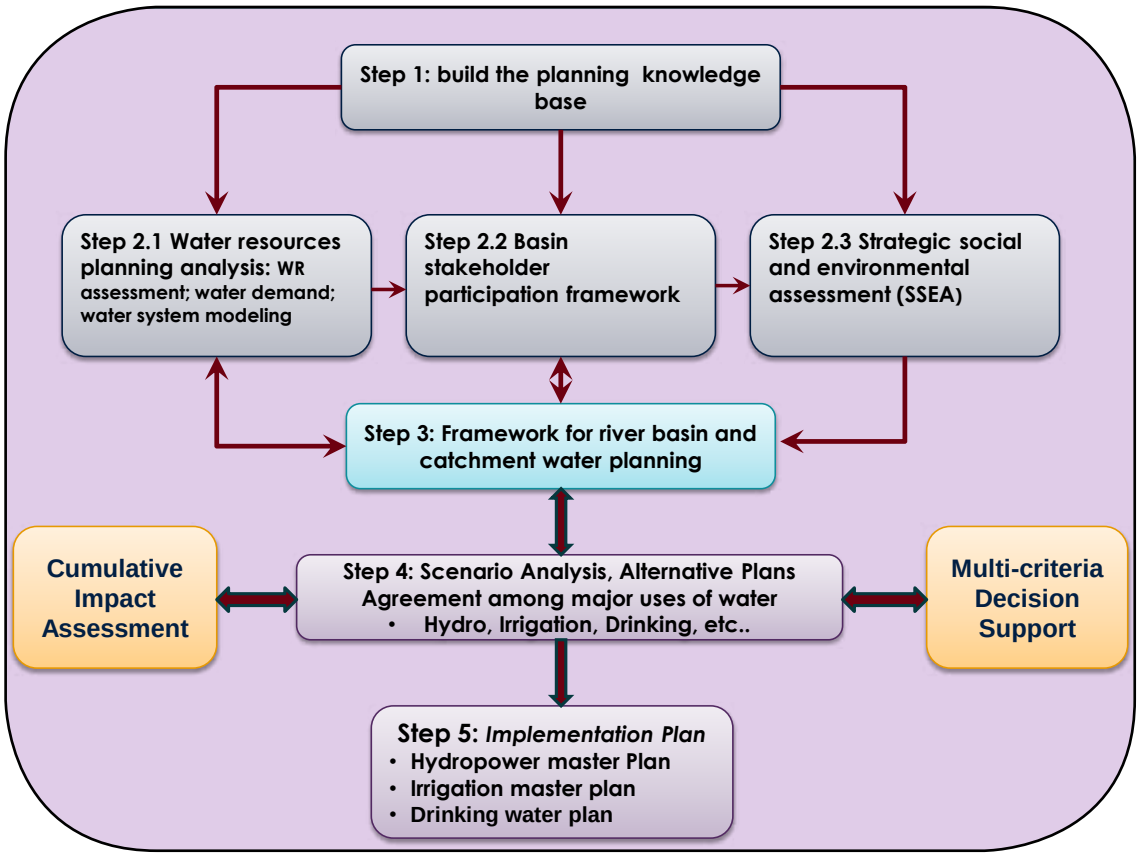
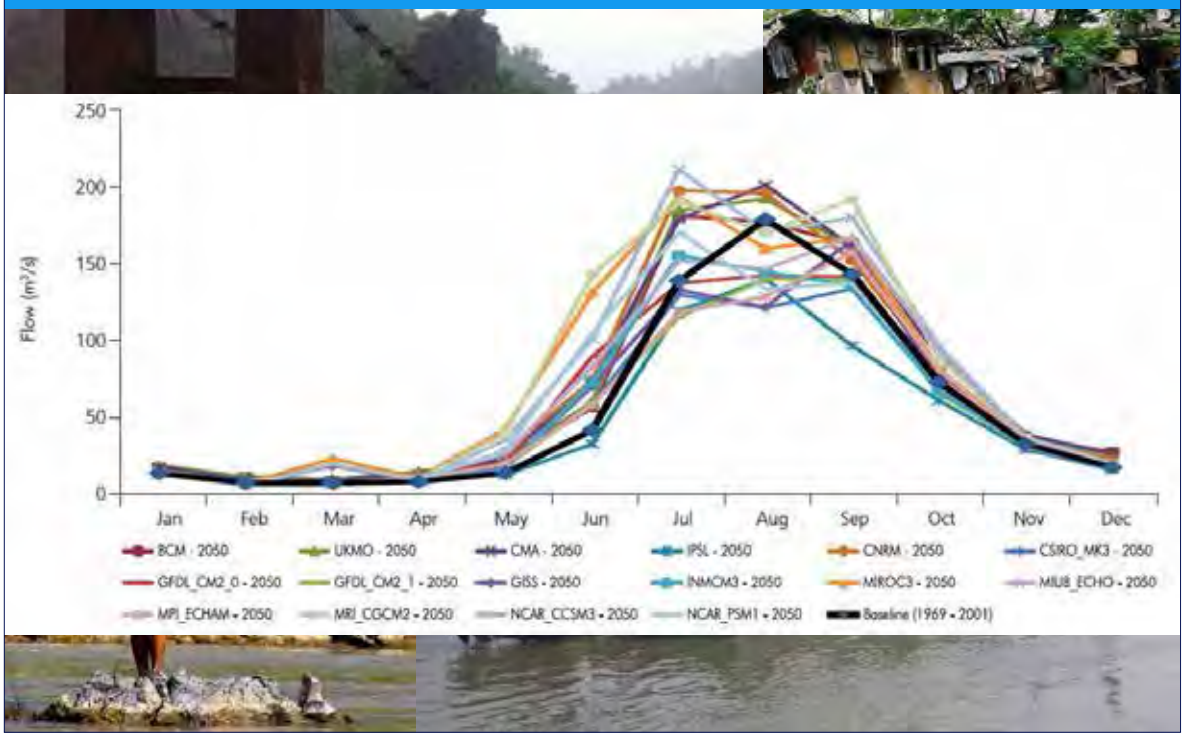


## Other important related issues




## Summary

- Ganges Basin has a huge water resource base that is critical to water, food and energy security
- The water resource base is under increasing stress and greatly improved management is required to support increasing demands
- The development priorities and opportunities differ amongst riparian countries
- Cooperation underpinned by shared data and knowledge is required to sustainably develop and better manage the resources of the basin
- Innovative ways to decouple aspects of the WEF are required and in particular to decouple economic growth from increasing water use

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# Caveats, sources and acknowledgements

- Data used in this presentation are from multiple sources – published and unpublished
  - Many sources provide conflicting numbers
  - Data for Ganges is generally fragmented and often unreliable; Some key data remain "classified"
  - Limited robust basin-scale analyses to inform debate
  - Main sources listed below; multiple other online sources
- Slides 3-6
  - Maps: Ganges Strategic Basin Assessment, Final Report, World Bank
  - Data: Ganges SBA; Gosain and Rao, *Pers. Comm.; www.eia.in*
- Slide 8
  - Gosain and Rao *Pers. Comm.*
  - *www.icid.org; FAO AQUASTAT Data online*
- Slide 12
  - Map: Prasad AK et al (2006) *Geophysical Research Letters*, 33(5)
- Slides 13-14:
  - Material from: Tushaar Shah, Stockholm Water Week 2014
- Slide17
  - Diagram from Gilmont (2014) *Water Policy*, 16
- Slides 26-27: Jie Tang, Lead Energy Specialist, World Bank, Nepal

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# THANK YOU

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Water

www.worldbank.org/water | www.blogs.worldbank.org/water | @WorldBankWater

## Annex VI: **Day I Presentation by Professor Ethan Yang**

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# System modeling of the Water-Energy-Food Nexus in the Indus and the Brahmaputra Basin

**Dr. Y. C. Ethan Yang**
**Research Assistant Professor**
**Fulbright WEF Nexus Regional Workshop**
**February 10 2015 @ Kathmandu, Nepal**

*Department of Civil and Environmental Engineering*

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## Outline

- Introduction
- Water systems modeling approach
- The Indus and Brahmaputra basin
- Results
- The way forward

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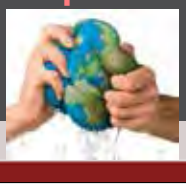
## Introduction

- According to IGEL (2013), 50% more agricultural production; 40% more energy and 30% more water are needed in 2030 globally.
- Complex hydrologic regimes and transboundary water tensions lead to a challenging water-energy-food nexus in the large river basins of South Asia.
- The goal of this talk is to quantify the water-energy-food nexus and evaluate impacts of different climate change and human developments on this nexus.

*Initiative for Global Environmental Leadership





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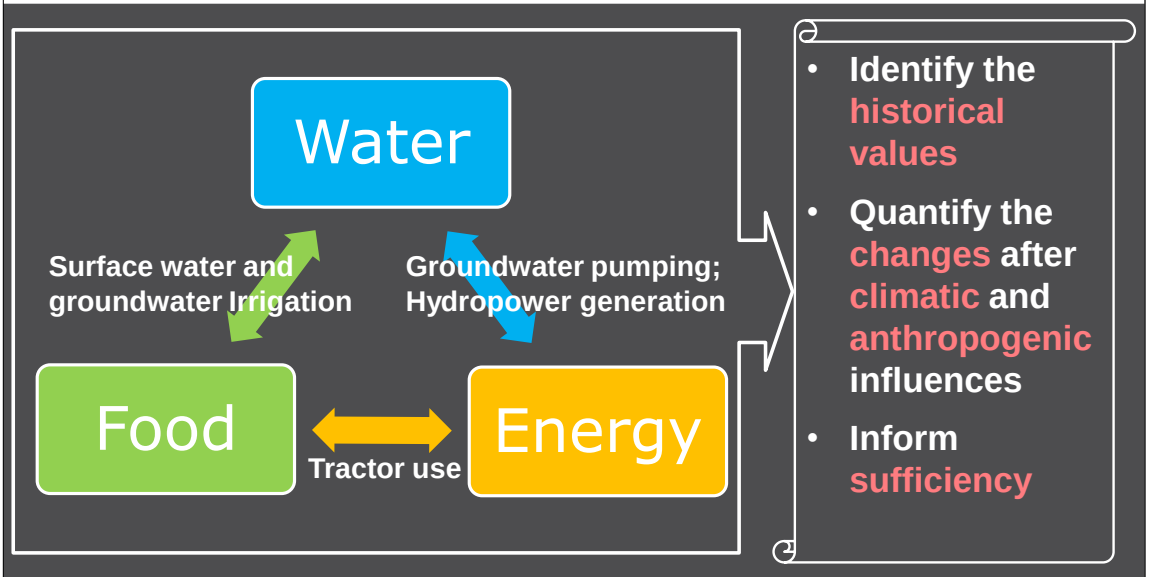
## Introduction




- Identify the historical values
- Quantify the changes after climatic and anthropogenic influences
- Inform sufficiency

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# Introduction

- **The World Bank**
  - ***Climate Risk Assessment for the Indus River Basin in Pakistan* (2011-2013)**
  - ***Future Visions of the Brahmaputra – Establishing Hydrologic Baseline and Water Resources Context* (2013-2015)**
- **International Food Policy Research Institute**
  - ***Using an upgraded Indus River Basin Model Revised (IBMR) for energy-water-food nexus assessment in the Indus River Basin under climate change impact* (2013-2014)**



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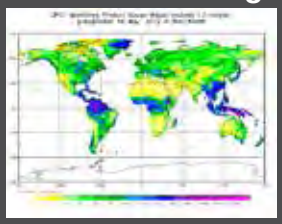
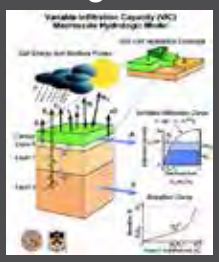
# Systems approach

- **Systems modeling approaches are used to quantify the water-energy-food nexus and inform security.**
- **Coupled modeling structure**

| Climatic forcing | Hydrologic modeling | Systems modeling |
|---|---|---|
|  |  |  |
| **Historical data, stochastic generated data and/or GCM informed data** | **Route the flow based on gravity only** | **Route the flow based on human purpose** |

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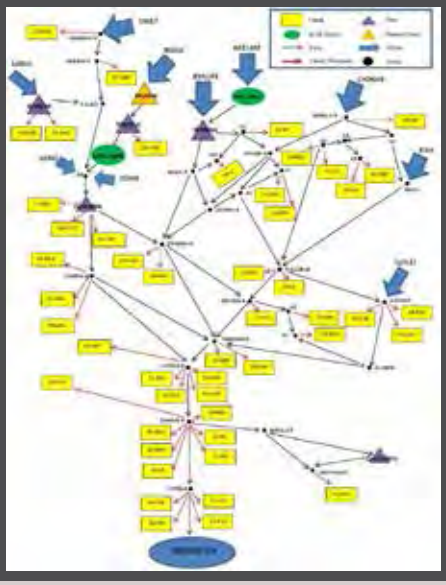
# The Indus River

**The Indus Basin of Pakistan**


**Indus Basin Model Revised – Multi Year**





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# The Indus River

- **Water infrastructure**
  - **Historical** ***(live storage: 12.47 MAF; installed: 6720 MW)***
  - **Mangla dam rising** ***(live storage: 15.33 MAF: installed: 7220 MW)***
  - **Mangla dam rising and Diamer-Basha Dam** ***(live storage: 21.73 MAF; installed: 11220 MW)***

- **Water governance**
  - **Historical (*warabandi*)** → **Canal level constraint**
  - **IRSA – optimization** → **intra-provincial optimization**
  - **Basinwide – optimization** → **inter-provincial optimization**

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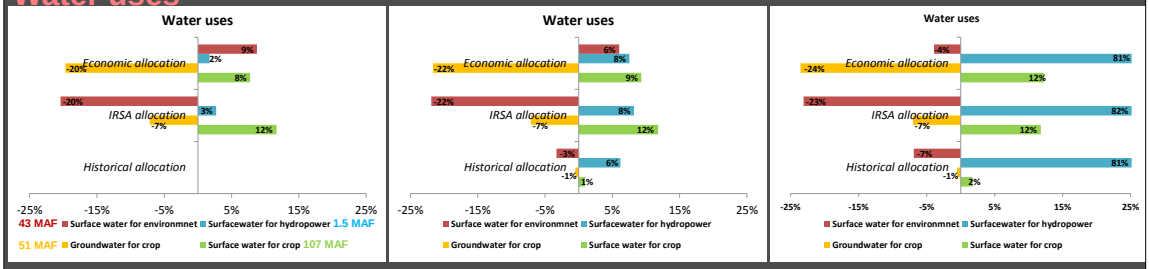
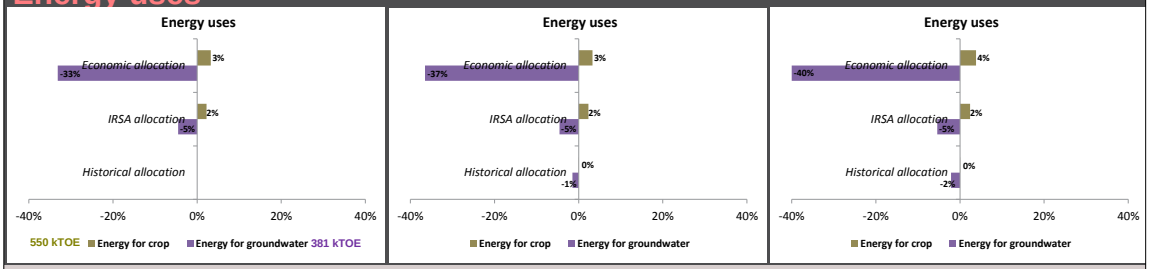
# Result - The Indus River – Basin uses

## Historical system | New Mangla | New Mangla & Basha

### Water uses




### Energy uses



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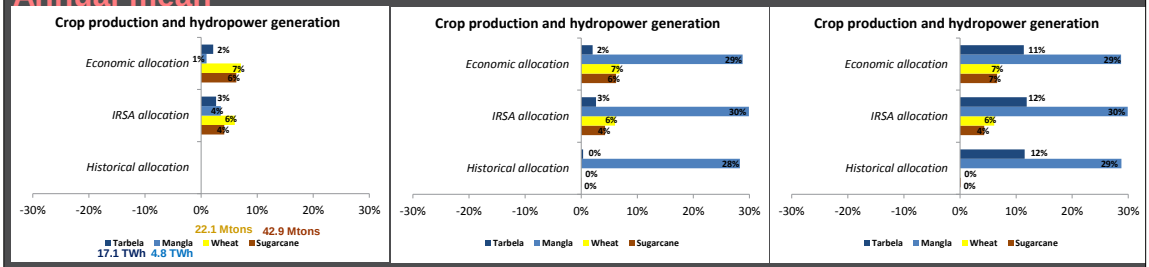
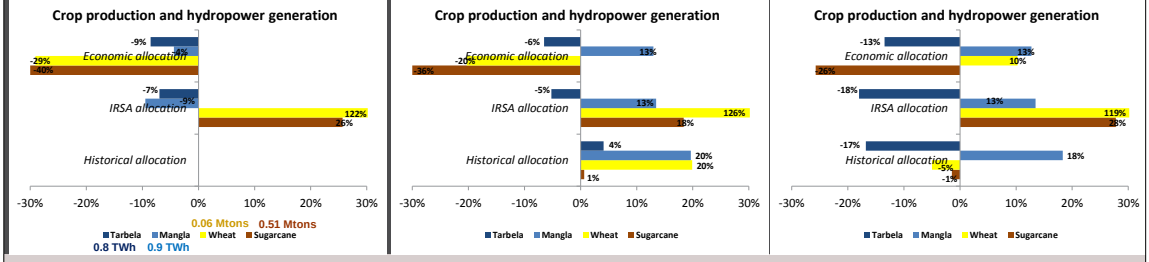
# Result - The Indus River – Basin production

## Historical system | New Mangla | New Mangla & Basha

### Annual mean




### Inter-annual variability



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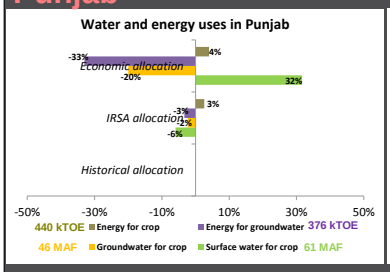
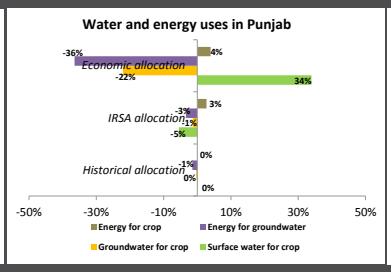
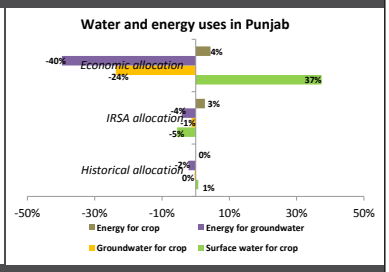
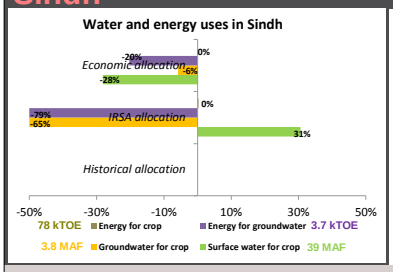
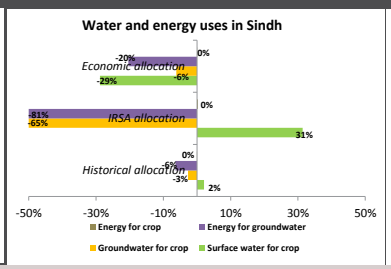
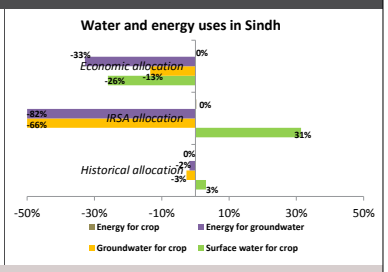
# Result - The Indus River – Provincial uses

| | Historical system | New Mangla | New Mangla & Basha |
|---|---|---|---|
| Punjab |  |  |  |
| Sindh |  |  |  |















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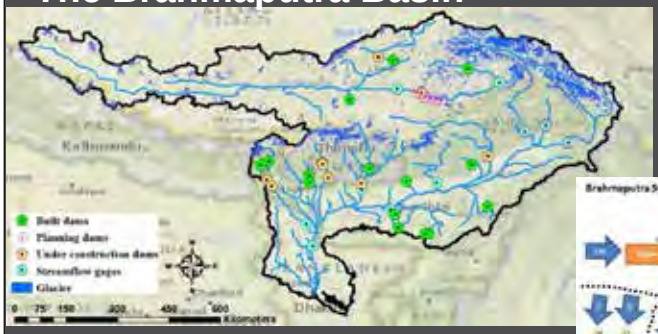
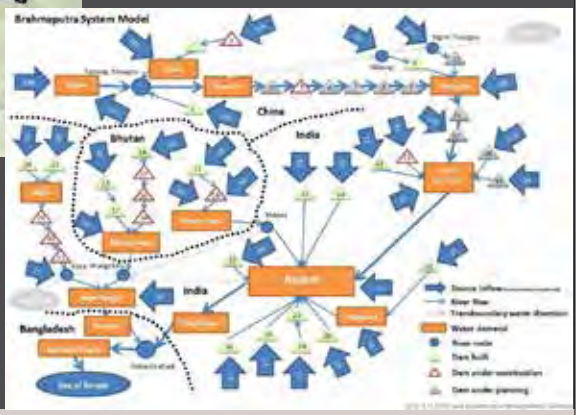
# The Brahmaputra River

## The Brahmaputra Basin




## Brahmaputra System model



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# The Brahmaputra River

- **Climate change**
  - Temperature changes from 0 to 10.5 degree C
  - Precipitation changes from -40% to 40%
  - IPCC CMIP 5 projections

- **Water infrastructure**
  - 2 new dams in China
  - 4 new dams in Bhutan
  - 4 new dams in India
- **Water diversion**
  - China's Greater Western Route Water Diversion Project
  - India's River Interlinking Project



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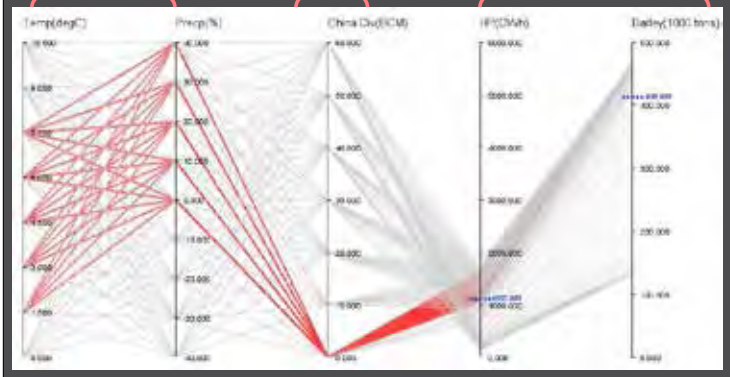
# Result - The Brahmaputra River – China's WEF

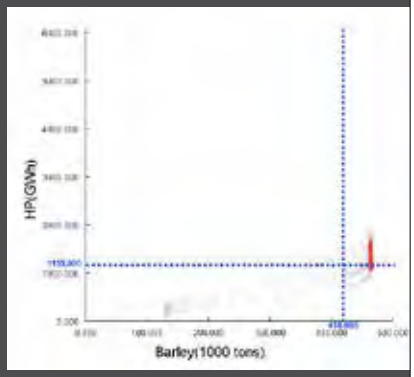
## Parallel coordinate plots

Climate | Human | Results of energy and food



## 2D plots

x-axis as food / y-axis as energy



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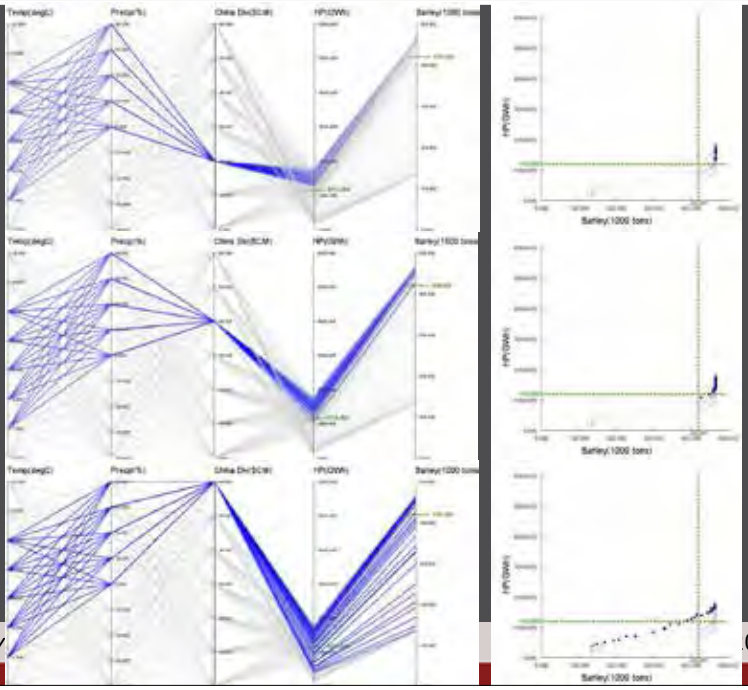
# Result - The Brahmaputra River – China's WEF

China diversions 20 BCM/year

China diversions 40 BCM/year

China diversions 60 BCM/year





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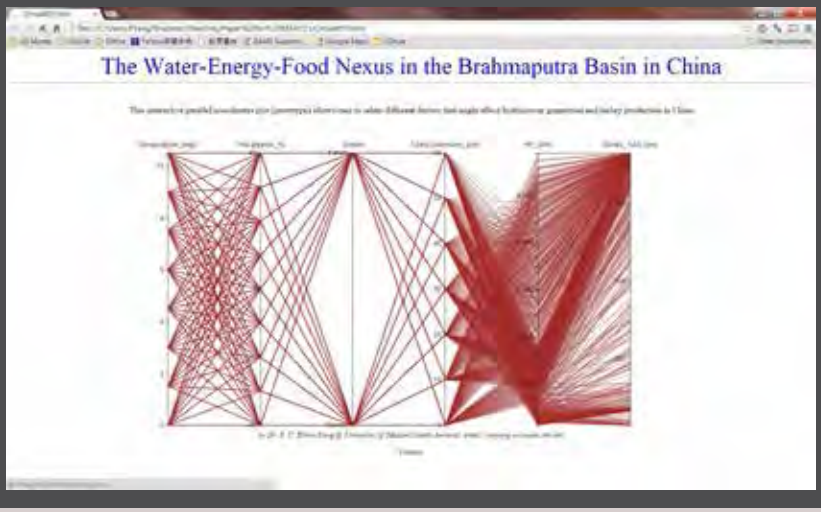
# Result - The Brahmaputra River – Online tool

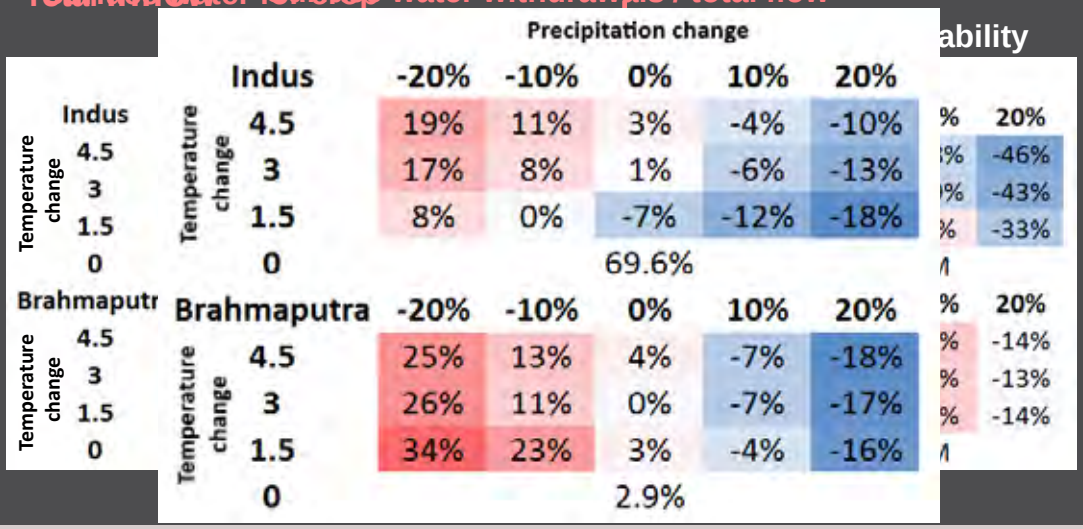
- An Interactive online tool for decision making: http://people.umass.edu/yceyang/ChinaWEF.html



# Result – Basin comparison

- Climate change impacts on two basins water uses

Total flow / Surface water withdrawals / total flow








# The way forward

- Systems modeling approach can quantify the water-energy-food nexus and inform security issue.
- Change surface water allocation scheme has an opportunity to reduce energy uses in Pakistan due to reduce groundwater pumping.
- New water infrastructure in Pakistan will increase the energy supply but not food supply under the assumption of no crop land change.
- Tibet's barley production and hydropower generation are relatively robust to climate change impacts but barley production is vulnerable to its own water diversions.

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## The way forward

- The interactive parallel coordinate plots visualized modeling results and provide an easier way for stakeholders to understand the complex water-energy-food nexus issue.
- Further studies:
  - Data collection
  - Link with or construct a energy market module for the water system model
  - Comprehensive uncertainty test (data, parameter and structure)
  - In-depth cross basin comparison



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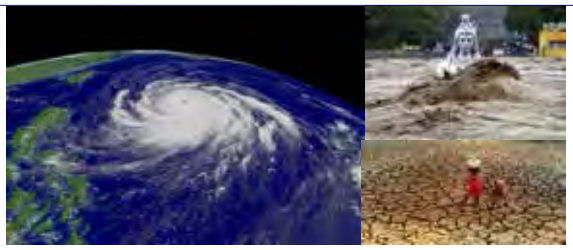
# Thank you!
# Any Questions?

**Y. C. Ethan Yang, Ph.D. GISP**
**Research Assistant Professor**
***yceyang@umass.edu***

# Annex VII: **Day I Presentation of BasinIT and Spatial Agent Tools**



## The Water-Energy-Food Nexus
## *Conceptualizing, Visualizing, Analyzing*

**Dr. Nagaraja Rao Harshadeep (Harsh)**

**Senior Environmental Specialist, The World Bank**

Kathmandu

February 10, 2015

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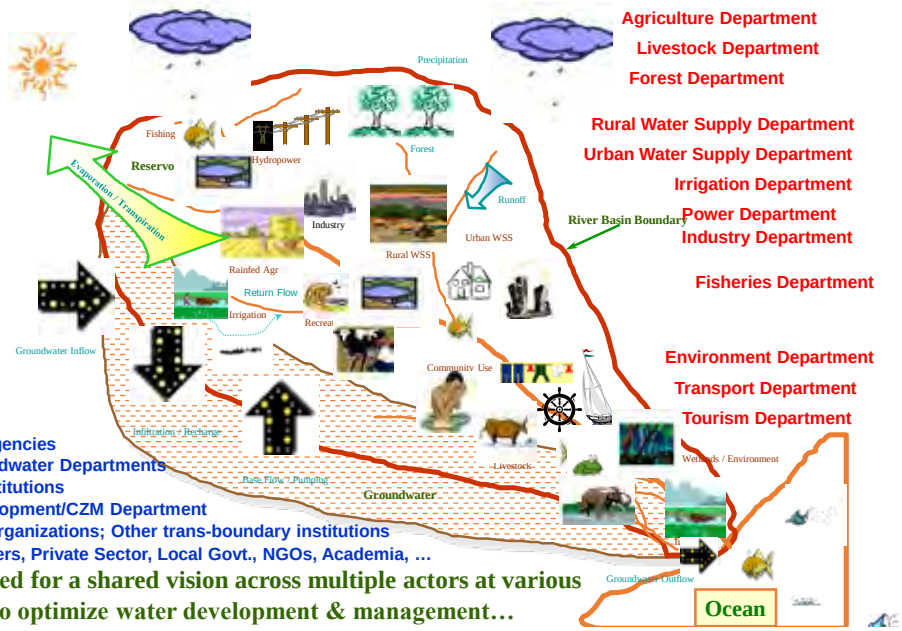
## Multiple sectors, multiple institutions, linked by water…

## A Typical River Basin…




Agriculture Department
Livestock Department
Forest Department

Rural Water Supply Department
Urban Water Supply Department
Irrigation Department
Power Department
Industry Department

River Basin Boundary

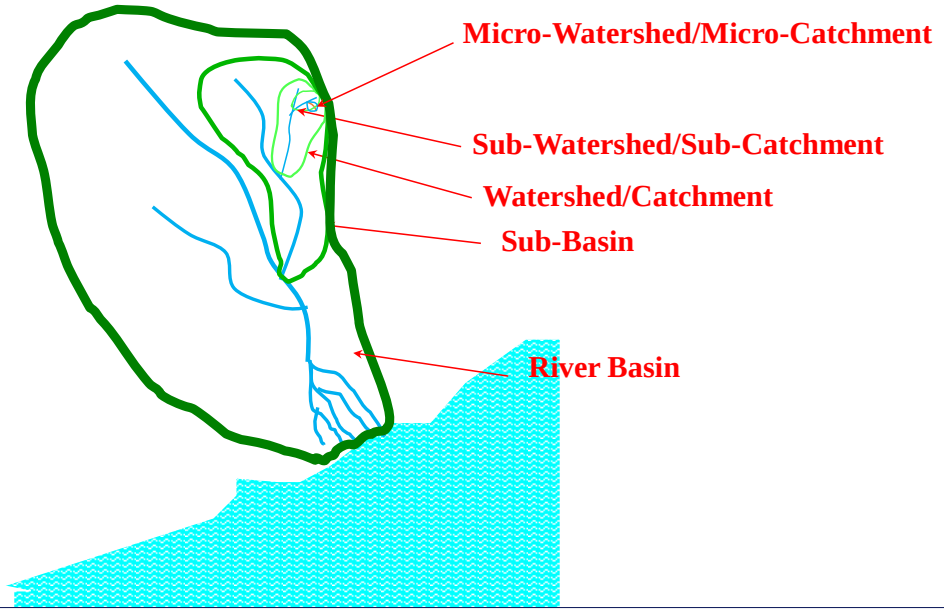
Fisheries Department

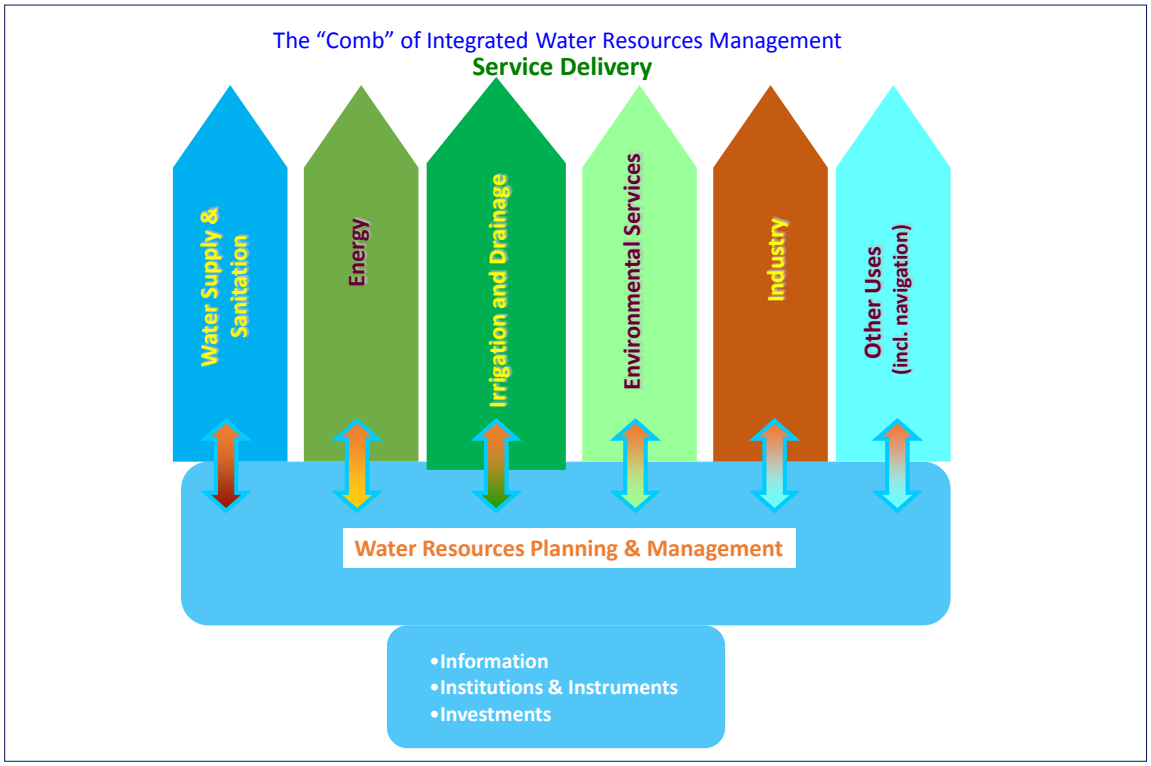
Environment Department
Transport Department
Tourism Department

Central & State Agencies
Surface & Groundwater Departments
Investment Institutions
Ocean Development/CZM Department
Basin Organizations; Other trans-boundary institutions
Farmers, Private Sector, Local Govt., NGOs, Academia, …

…there is a need for a shared vision across multiple actors at various spatial scales to optimize water development & management…

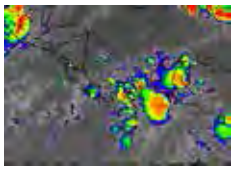
## Basin? Watershed? Catchments?



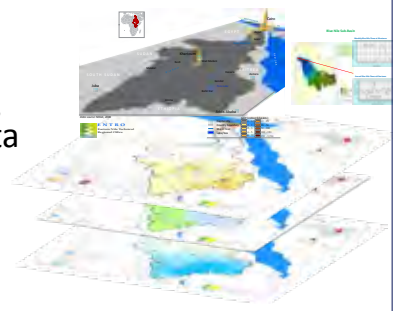


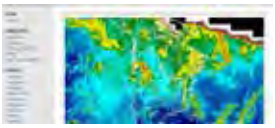

## Innovative Solutions in an Integrated Water Resources Perspective...

# Information & Analysis



- **Resource Information Base** (data rescue; monitoring; comprehensive spatial, temporal and other databases; improved use of satellite data; documents)
- **Knowledge Products/Special Studies** (maps, Atlases, interactive toolkits, surveys)
- **Access and Outreach mechanisms** (publications, web portals, Apps with public access to open data services, technical/ success stories, multi-media documentation)
- **Analytical Tools** (models/Decision Support Systems for planning/operations support in an IWRM systems context)

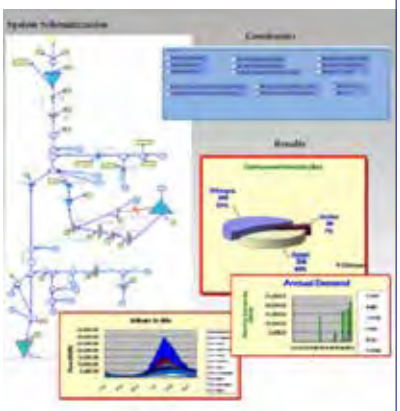


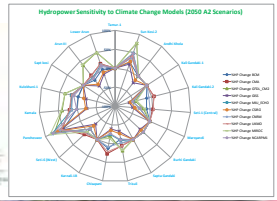


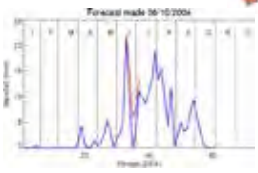
# Modernizing tools to support decisions…

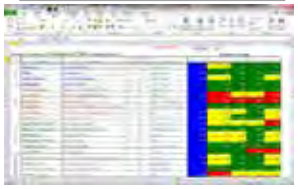
- Investment planning
- System operations

*To optimize the development and management of the resource base for sustainable social, economic, and environmental benefits to current and future generations*







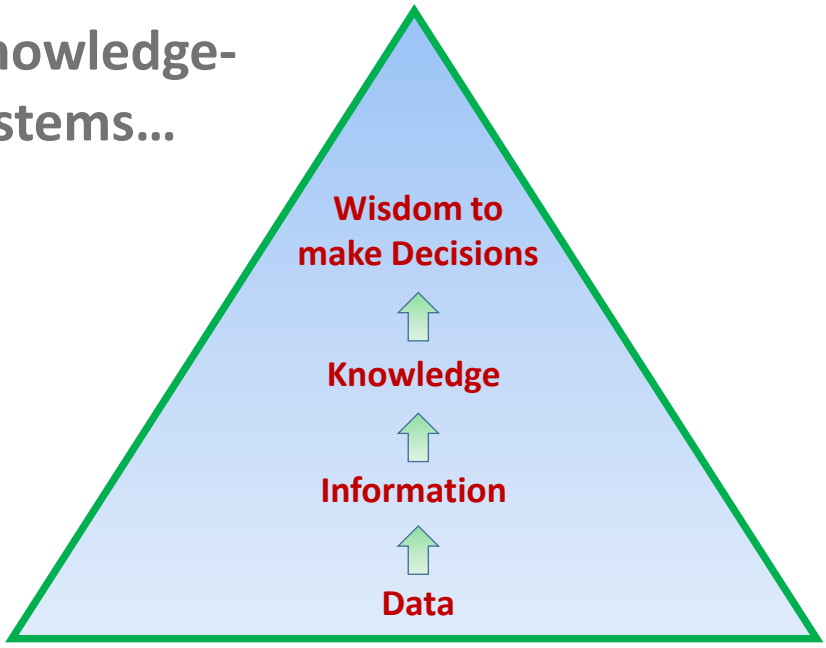
## Institutions & Policy

- **Strengthening Institutions** (office modernization, stakeholder participation, capacity development and training incl. distance learning, improved links with academia, internships, visiting experts, professional networks/ communities of practice; forums, competitions)
- **Strengthening Policies** (streamlining institutional design/policy/mandates, improving synergy, economic instruments, decentralization)

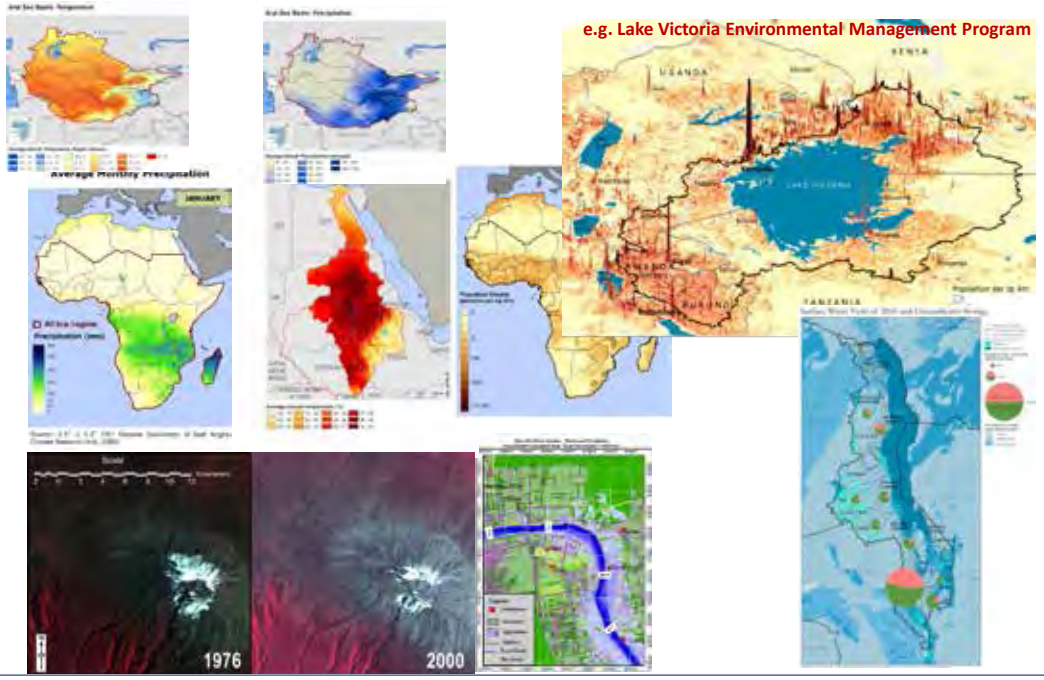
## Investments & Operations

- **Preparation of a robust on-the-ground investment pipeline** (with adequate attention to technical, environmental, social, economic, and institutional aspects)
- **Implementation facilitation, monitoring, and lessons** (adequate technical assistance, ownership, M&E)

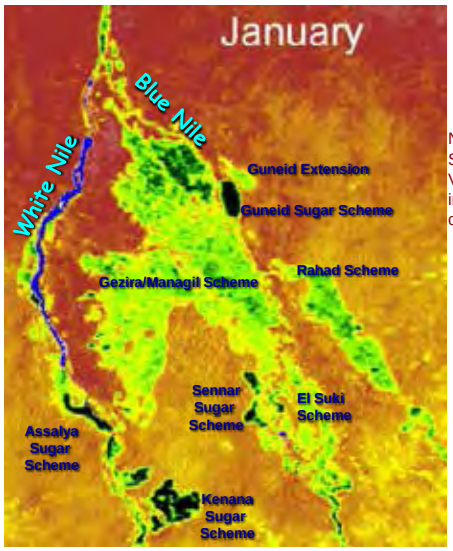
## Need to modernize shared knowledge-driven systems…




## Knowledge Base

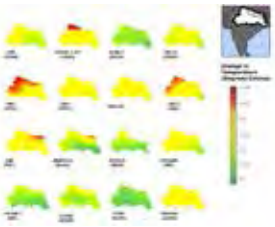


## Innovative Spatial Visualizations: 2D/Animations

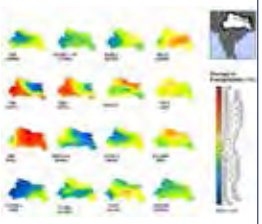



NDVI from SPOT-Vegetation in 10-daily composites

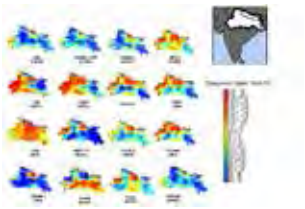

**TEMPERATURE**



**PRECIPITATION**

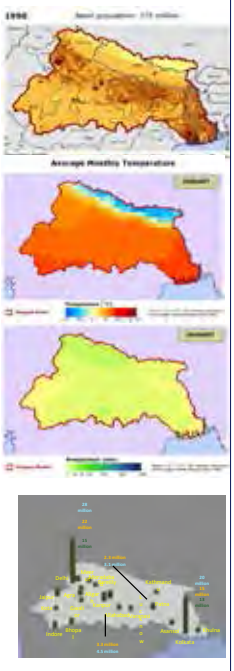


**RUNOFF**



## An Illustration of the Ganges Basin



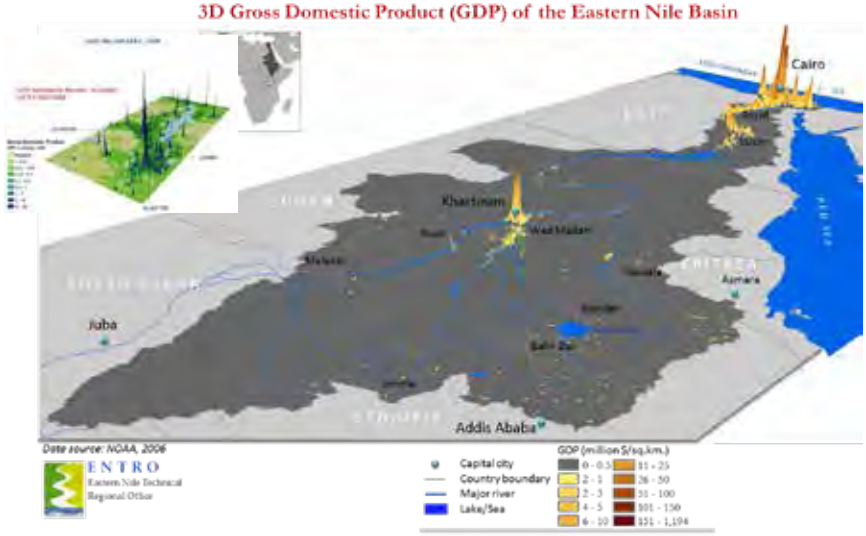



## Innovative Spatial Visualizations: 3D

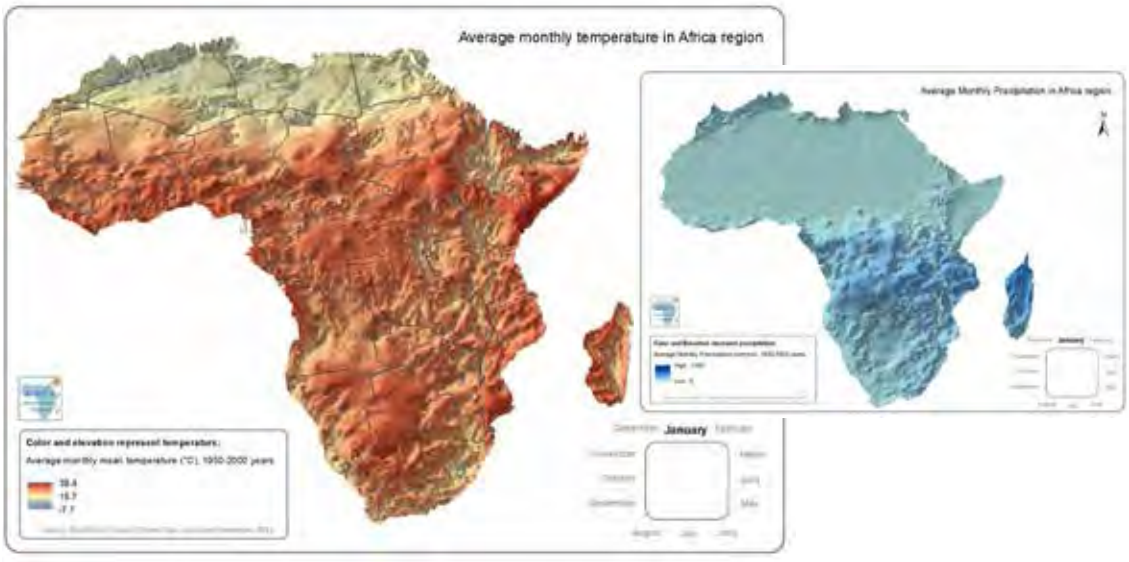
Poverty Maps

**Poverty & Prosperity**

3D Gross Domestic Product (GDP) of the Eastern Nile Basin

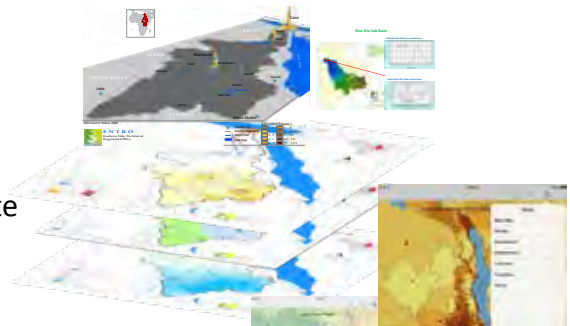



## Innovative Spatial Visualizations: e.g. 4-D?



# Knowledge Products

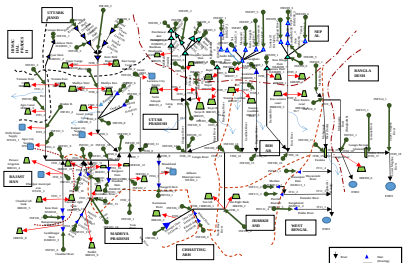
- Public Domain Datasets/Products
- Innovative Visualizations
- Hardcopy and Interactive Atlases
- State of the Basin Reports
- Interactive Collaborative Portal/Website
- Mobile “Apps”
- Bulletins/Newsletters
- …

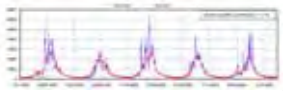


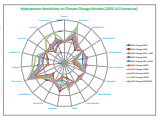
# Modernizing tools to support decisions…

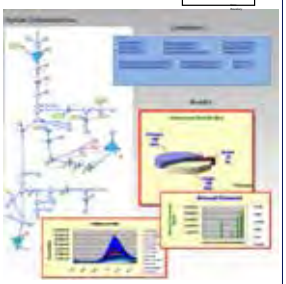
- **Investment planning**
- **System operations**
- **Early warning/Alerts**

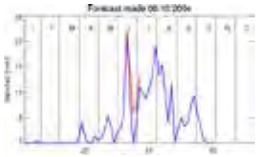
*To optimize the development and management of the resource base for sustainable social, economic, and environmental benefits for current and future generations*

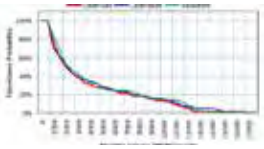




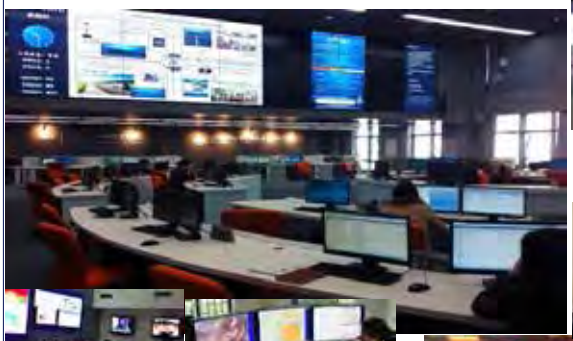


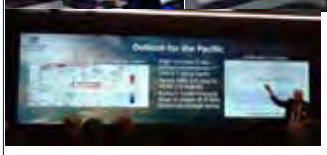


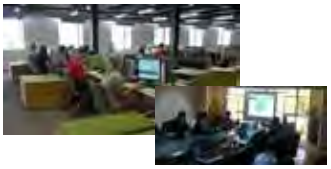




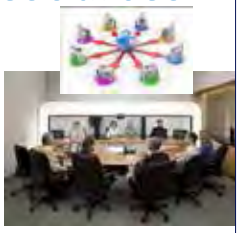
# Institutional Modernization of Water Resources





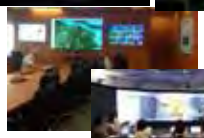


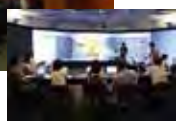
Collaborative Workspaces/Internships



Audio/Video-Conferencing/ Distance Learning/ Helpdesk

Computer Training Room





Situation/ Decision Room

Document, Map & Digital Library

Innovation Marketplace

# Possible Functions for the Water Centers of Excellence

**Collation**

**Knowledge Repository**

- Data Rescue - Computerization of legacy data
- Digital and hardcopy library of all reports
- Targeted Surveys
- GIS and Remote Sensing Archive
- Other Databases (incl documents, videos)
- Online Data and Mapping Services

**Monitoring Hub**

- Integration of "bottom-up" and "top-down" monitoring data - collation, analysis, visualization through maps, graphs, schematics, indicator tracking
- Integration of crowdsourcing information

**Analysis**

**Knowledge Tools/Products**

- Maps, Atlases (hardcopy and interactive)
- Benchmarking
- Targeted Analysis
- Analytical tools
- Publications/ Multi-media products
- Online data and map services
- Portals & Apps with appropriate dashboards

**Targeted Research**

- Deputation/ Internship/ young professional/ visiting expert activities
- Facilitating collaborative and demand-driven research
- Innovation/ Applied Technology Competitions/ *Appathons*

**Use**

**Outreach & Capacity-Building**

- Knowledge Dissemination, Communications & Outreach (incl. multi-media documentation, public domain information, newsletters, awareness, media, workshops, partnerships)
- Training/Distance Learning (incl. e-learning, VCs)
- Participatory mapping/ planning
- Knowledge exchange forums at various levels

**Institutional Support**

- Facilitating information sharing and synergy across agencies and levels
- Facilitating policy and decision making
- Improving public-domain information access
- Improving partnerships
- Helpdesk services

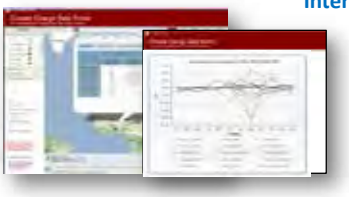
# Many new Innovations

Google Earth/Similar Products



Interactive Documents

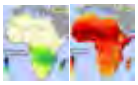
Innovative Hardware
(e.g. Tablets)



Online Portals

## Building on curated public-domain datasets…

Irrigated, Rainfed Areas (IWMI, FAO)



Historical Climate (CRU/UEA)

Climate Change (IPCC, TNC/WB)

Climate/Flow data (KNMI, GRDC, …)

Gridded GDP (Yale, NOAA)

DEM (SRTM, ASTER)

CO2 emissions (EDGAR-JRC-PBL, …)
C Biomass (Winrock)

Biodiversity (CI, WWF, IUCN…)

Flood/Drought (DFO, GDACS, UNEP…)

Landcover (ESA, USGS, …)

Population (CIESIN, Landscan, …)

Soils (UNESCO, FAO, …)

# Modern “Bottom-up” Monitoring tools

**Commercial**
Disaster Monitoring Constellation
Pléiades
EROS A & B
FORMOSAT-2
IKONOS
QuickBird
RapidEye
SPOT
TerraSAR-X & TanDEM-X
COSMO-SkyMed
WorldView-1
WorldView-2
GeoEye-1
Planet Labs

**Earth Observing System**
Aqua&Terra (MODIS)
Aura
GRACE
Jason 1
Ocean Surface Topography Mission
Orbview-2
Orbiting Carbon Observatory 2
TRMM

**GOES (Geostationary Operational Environmental Satellite)**
GOES 13
GOES 14
GOES 15

**Polar Operational Environmental Satellites**
NOAA-15
NOAA-16
NOAA-18
NOAA-19
METOP-B
METOP-A

**Joint Polar Satellite System**
Suomi NPP

**Japan Meteorological Agency**
MTSAT-1R / Himawari-6[3]
MTSAT-2 / Himawari-7[3]

**Landsat program**
Landsat 7
Landsat 8

**Brazilian Space Agency (AEB)**
CBERS-1
CBERS-2
CBERS-2B

**Argentina Space Agency (CONAE)**
SAC-A
SAC-B
SAC-C
SAC-D
SAOCOM

**Centre National d'Études Spatiales (CNES)**
SPOT
Pléiades
TOPEX/Poseidon

**European Space Agency (ESA)**
Envisat
ERS (1 & 2)
CryoSat-2
Sentinel 1

**Indian Space Research Organisation (ISRO)**
Megha-Tropiques
Oceansat-2
IMS-1
Cartosat-2A
CARTOSAT-2
IRS P5 (CARTOSAT-1)
IRS P6 (Resourcesat 1)

**JAXA**

MOS-1 (Momo-1)
MOS-1b (Momo-1b)
JERS-1 (Fuyo-1)
ADEOS (Midori)
ADEOS II (Midori II)
GOSAT (Ibuki)
ALOS (Daichi) PALSAR, AVNIR-2 and PRISM
Lembaga Penerbangan dan Antariksa Nasional (LAPAN INDONESIA)
Lapan-TUBsat

**NASA**
TIMED (Thermosphere Ionosphere Mesosphere Energetics and Dynamics)
TOPEX/Poseidon
Upper Atmosphere Research Satellite

**NOAA**
NOAA-4
Project Vanguard
Vanguard 2

**National Academy of Sciences of Republic of Belarus**
BelKA

**Pakistan's SUPARCO (Space and Upper Atmosphere Research Commission)**
Badr-B - 2001.
Pakistan Remote Sensing Satellite - Scheduled 2014.

**Russian Federal Space Agency** (Roscosmos)
Elektro–L
Monitor-E
Resurs-DK1
Resurs-P No.1

**Swedish National Space Board**
Munin

**Bolivarian Agency for Space Activities**
VRSS-1

**Meteosat**
MetOp
Meteosat 5
Meteosat 6
Meteosat 7
Meteosat 8
Meteosat 9

**RADARSAT series**
RADARSAT-1
RADARSAT-2

**South Korea**
Arirang-1
Arirang-2
Arirang-3
Arirang-5
Chollian

**THAILAND**
Thaichote

**Turkey**
Göktürk-2 (2012) (IMINT), RASAT (2011), Mapping BILSAT-1 (2003-2006)
Göktürk-1 (2013) (IMINT), Göktürk-3- (IMINT), High Resolution Synthetic aperture radar (SAR) Earth observation satellite

**Weather**
TIROS-1
TIROS-2
TIROS-3
TIROS-4
TIROS-5
TIROS-6
TIROS-7
TIROS-8
TIROS-9
TIROS-10

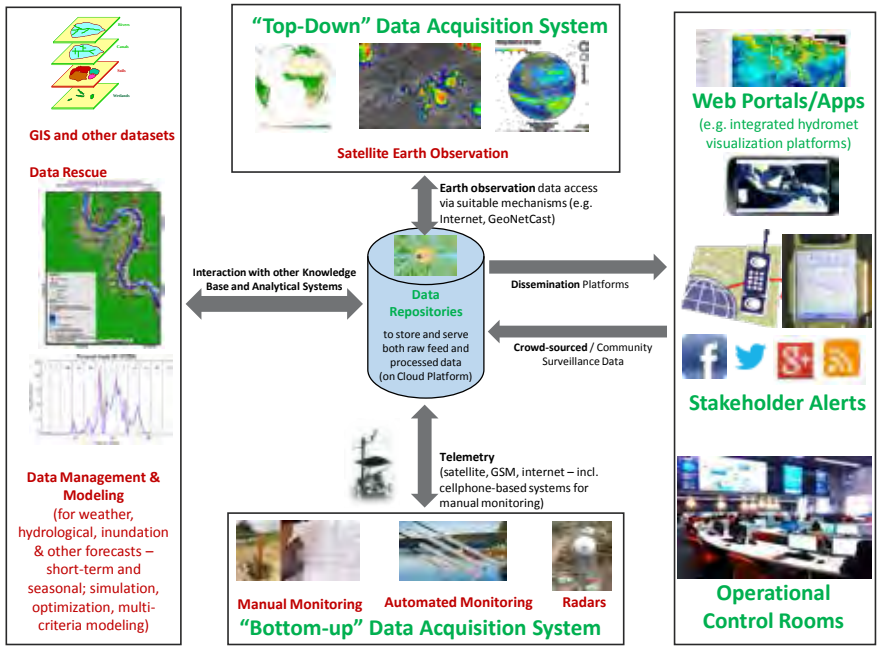
**Meteor series**
Meteor 1 series
Meteor 2 series
Meteor 3 series

**FY (Feng Yun) series**
FY-1 series
FY-2 series
FY-3A

## Many Eyes in the Sky…

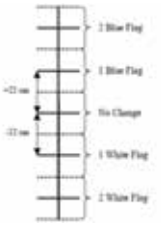
## "Top-down" Measurements from Space


## ...that can be integrated into a modern Water Resources Information Services Platform (usable at national, state, and local levels)



## A new world for "last mile" connectivity

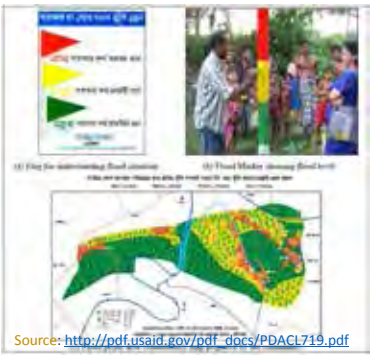
-Multiple media
-Internet
-Cellphones
-Flags
-Preparedness plans



Flag hoisted at the community at Bhalkutia Mauza, Nagarpur Upazila showing rise in water level (blue flag) by 3 bighat

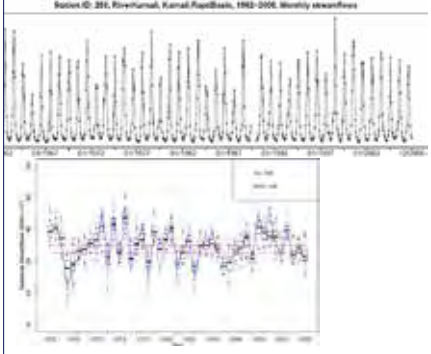

CEGIS Flood Info: Lautara 7-Sep-2007 14:21 ++ (Courtesy Banglalink)
Here,
A = Source of flood forecast message
B = *Mauza name*
*C = Date*
*D = Time of sending message*
*E = Rise or fall of water level: One plus sign (+) means one bighat (22cm) rise of water level, one minus sign (-) means 1 bighat (22cm) fall of water level.*

*F=CourtesytoBanglalink*



Source: http://pdf.usaid.gov/pdf_docs/PDACL719.pdf

## Improving Seasonal Hydrologic Forecasts



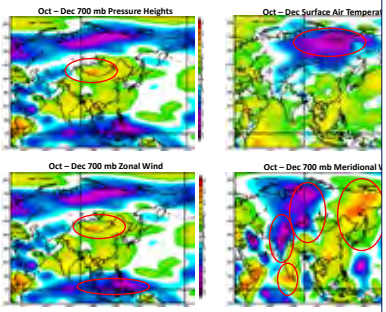
## Illustrative Predictors

**Large scale climate variables:**

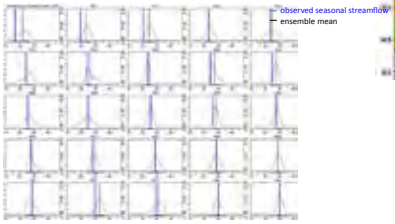
700 mb Geopotential Height [GPH]; Surface Air Temperature [SAT]; 700mb Zonal Winds [ZW]; 700mb Meridional Winds [MW]; Sea Surface Temperatures [SST];

**Teleconnection indices:**

Antarctic Oscillation [AAO]; Atlantic Multidecadal Oscillation [AMON]; Arctic Oscillation [AO]; Atlantic Tripole SST EOF [ATL TRI] ; Caribbean Index [CAR] ; Indian Ocean Dipole, i.e., Dipole Mode Index [DOI]; Eastern Asia/Western Russia [EA]; Tropical Pacific SST EOF [EOFPAC] ; East Pacific/N.Pacific Osci. [EP-NP/EPO] ; North Atlantic Oscillation [NAO] ; Extreme Eastern Tropical Pacific SST [NINA1] ; Eastern Tropical Pacific SST [NINA3] ; East Central Tropical Pacific SST [NINA 34] ; Central Tropical Pacific SST [NINA4] ; Northern Oscillation Index [NOI] ; North Tropical Atlantic Index [NTA] ; Pacific Warmpool [PACWARM] ; Pacific Decadal Oscillation [PDO] ; Pacific North American Index [PNA] ; Southern Oscillation Index [SOI] ; Tropical Northern Atlantic Index [TNA] ; Tropical Southern Atlantic Index [TSA]




PDF plots, Jan. 1st issued forecasts

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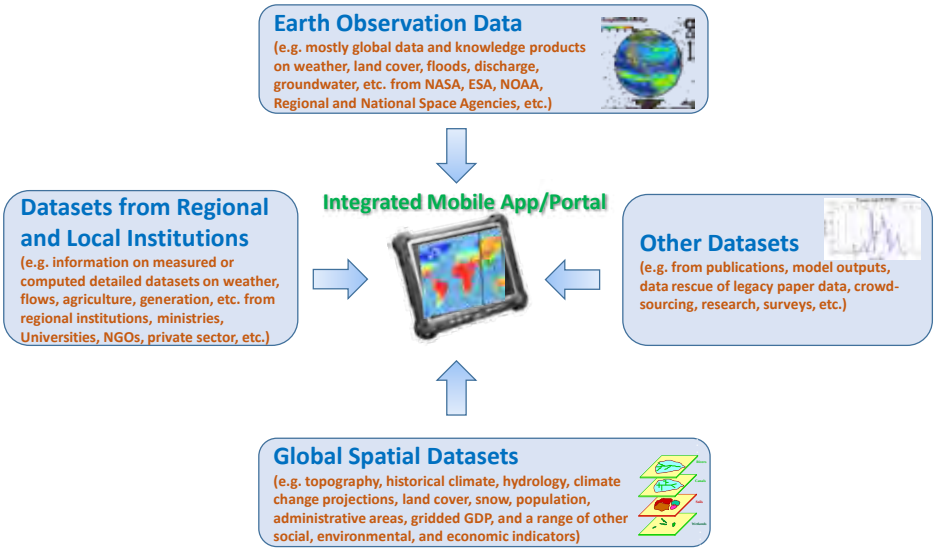
## Data Access and Visualization

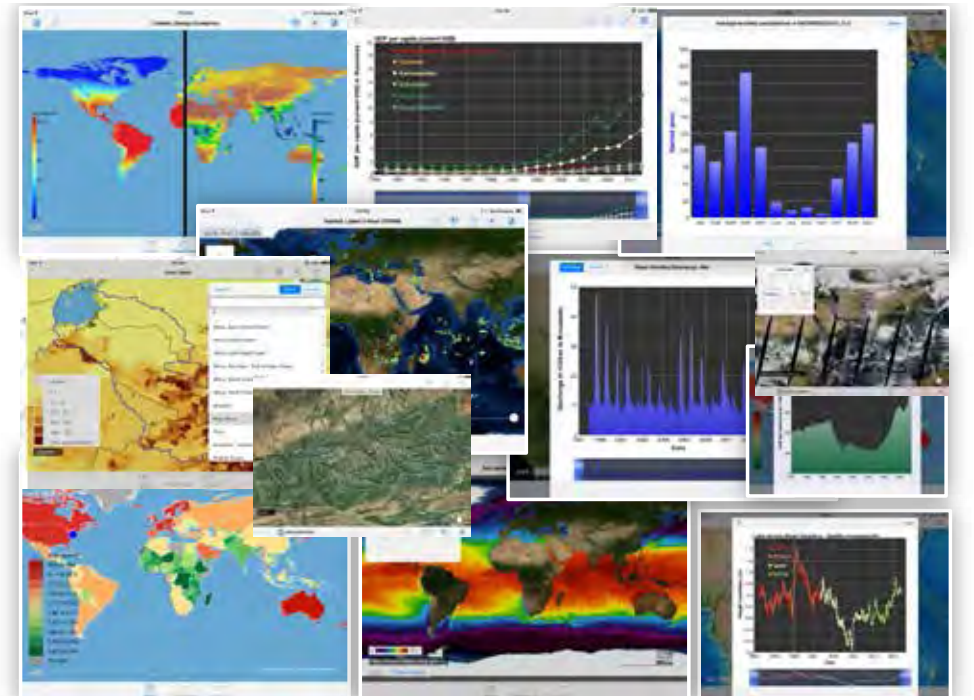
**An Exciting New World Ahead!**





Download free from: http://apps.worldbank.org

ioS (iPad and iPhone): search "Spatial Agent" on Appstore or from https://itunes.apple.com/us/app/spatial-agent/id890565166?mt=8
Android Beta: http://www.appsolutelydigital.com/SpatialAgent/SpatialAgent.apk
*Web version also being developed.*



# Introduction to Basin-IT


For more information on Basin-IT, pls. contact Mei Xie, LLI (mxie@worldbank.org)

# Basin-IT

**What it will help with?**

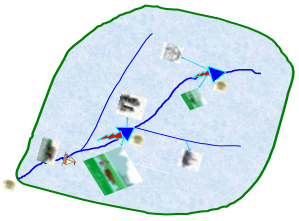
- Illustrative teaching tool for learning about some of the linkages in an IWRM context in a hypothetical basin
- Encourage group thinking about inter-sectoral and spatial inter-connectivity

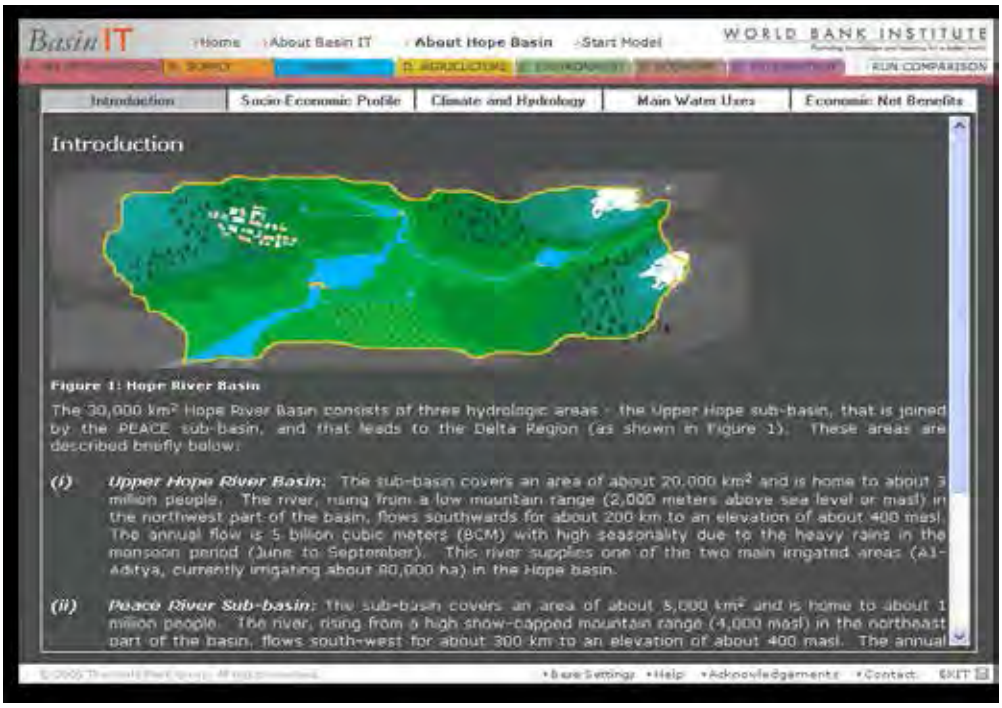
**What it will NOT help with?**

- Exploring a more comprehensive set of options or scenarios for the "Hope" basin
- How to develop a model (or adapt this model) for a basin of your interest?
- How to learn to use GAMS or Visual Basic?
- How to learn about different types of models?

# BASIN-IT

- Developed as a training tool at the World Bank
- Developed for a hypothetical basin to illustrate the inter-sectoral (e.g. agriculture-energy-environment) and spatial (e.g. upstream-downstream) linkages
- Uses GAMS (Generalized Algebraic Modeling System – more info at http://www.gams.com ) originally developed at the World Bank and a Visual Basic interface.





- **S** – Sub-basins
- **R** – Reservoirs
- **A** – Agriculture
- **U** – Urban
- **E** – Wetlands
- **G** – Groundwater


**Climate Scenario:**

- Normal
- Dry
- Wet
- Climate Change

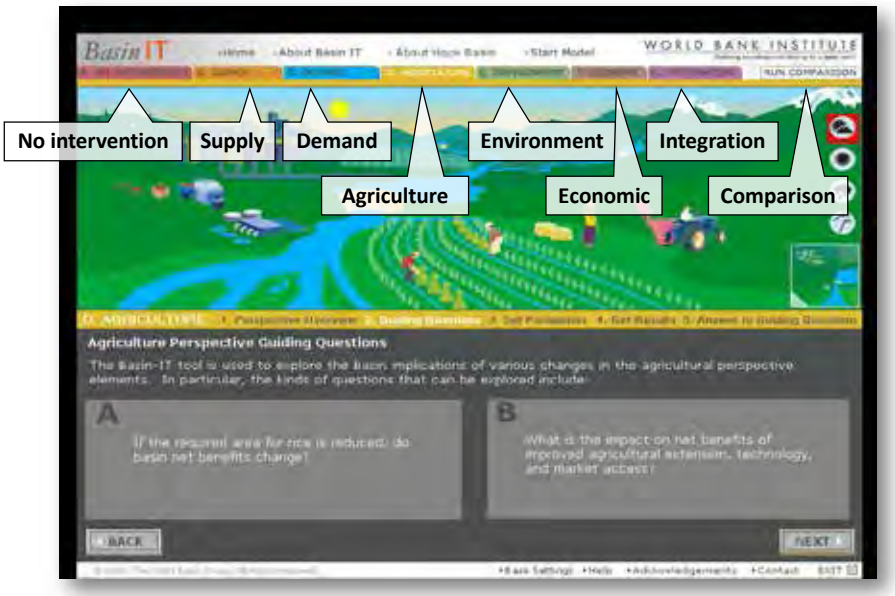
## Start analysis ....


## Perspectives of Analysis

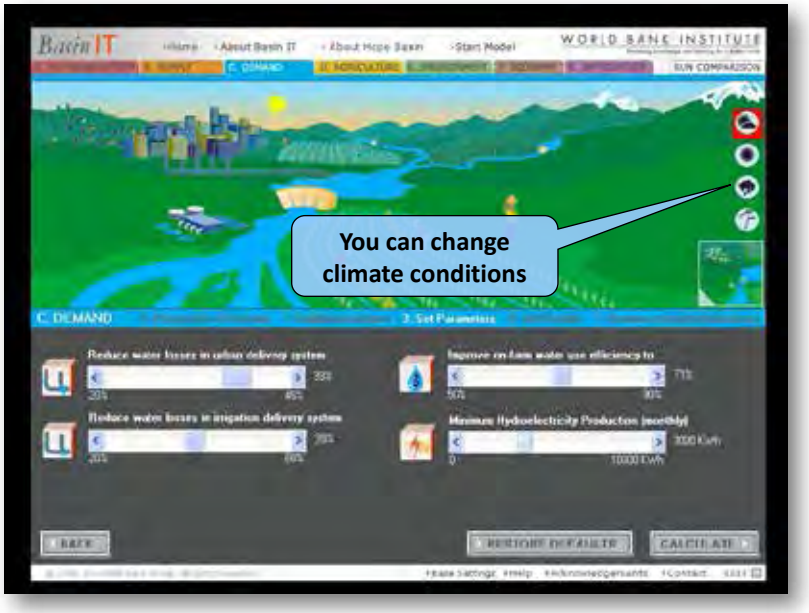
1. No intervention
2. Water supply driven - *storages*
3. Agriculture policies -
4. Water demand driven -
5. Environmental considerations
6. Economic incentives – prices

**Integration of all the above**

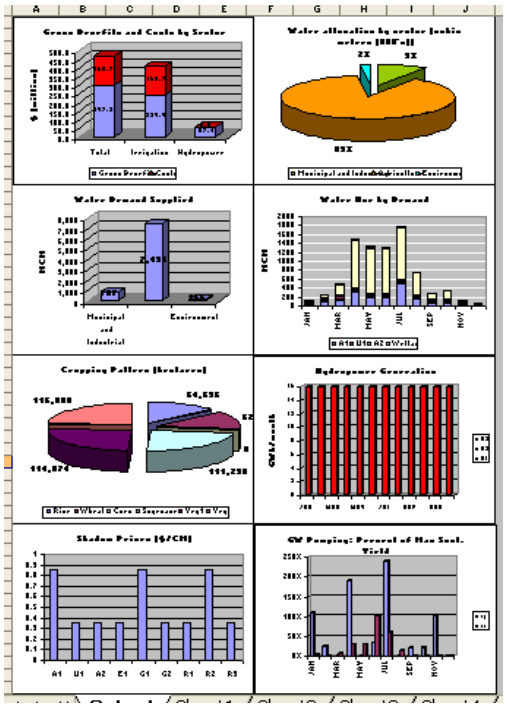
## Guiding question examples ….




## Example – “Demand Perspective”



## Result Analysis ….

## Present results visually…

- Water allocation
- Basin net benefit
- Shadow price of water
- Groundwater pumping
- Hydropower output
- Cropping patterns

## Sample questions that BASIN-IT can help explore…

- How does an additional dam impact net basin revenues?
- How much do you gain in basin benefits if you reduce urban water losses or improved irrigation delivery?
- Are demand-side measures always a good investment?
- Do higher prices or lower water prices produce better total economic benefits?

## *GroupWork*

## Work with your group to:

- Follow on-screen test exercises (including saving results) & experiment with the choices.
- Choose a Group Development Priority
  A. Agriculture
  B. Energy
  C. Environment
- From your group priority perspective – save and show the
  - "Best" scenario only considering your group priority
  - "Balanced" scenario that your group could accept, showing some consideration of other group priorities
  - "Worst" scenario if other group priorities ignored your group priority

# Thanks!

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Senior Environmental Specialist

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harsh@worldbank.org

# Annex VIII: **Day II Presentation by Dr Aditi Mukherji**

ICIMOD 30

## Water-energy-food nexus in South Asia:
### Role of mountains and groundwater

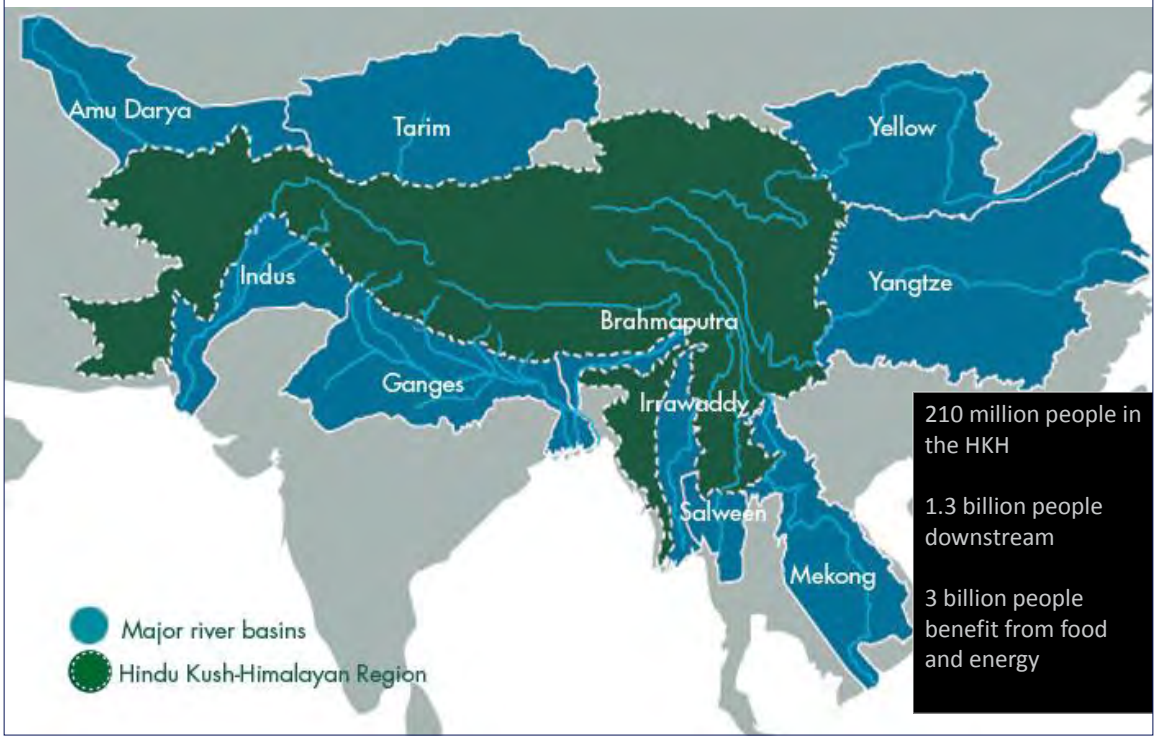
Aditi Mukherji
Theme Leader, Water and Air
11th Feb, 2015, Kathmandu

International Centre for Integrated Mountain Development

Kathmandu, Nepal

THREE DECADES
FOR MOUNTAINS AND PEOPLE

## HKH is the source of ten major river basins



# Supports extensive irrigation systems

ICIMOD 30

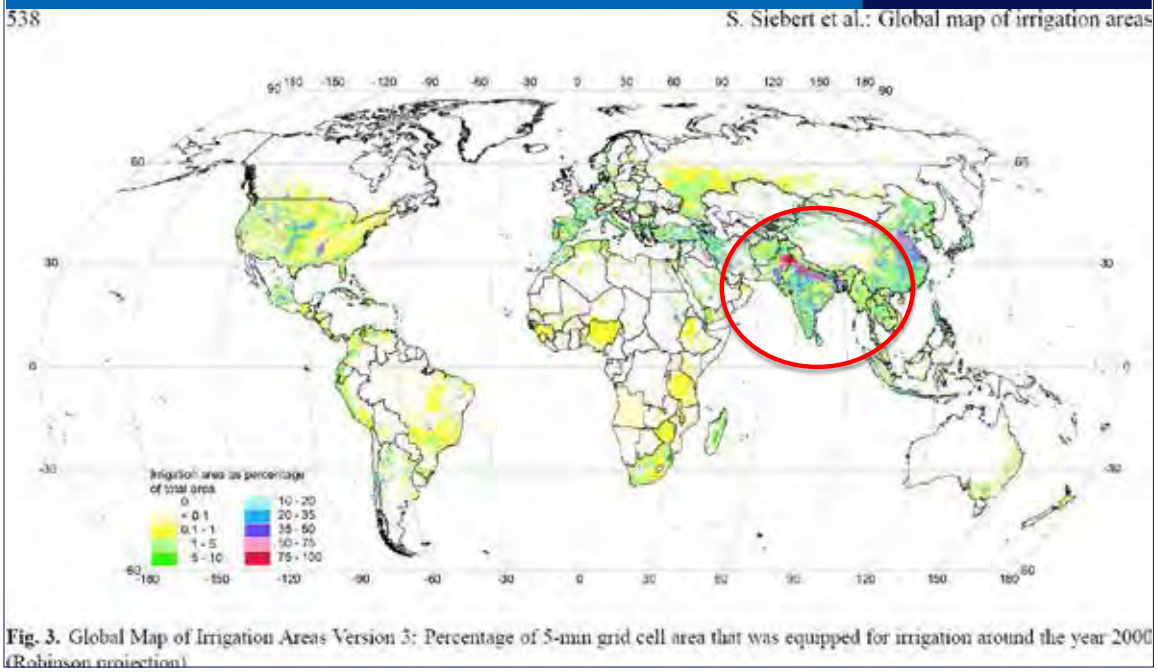
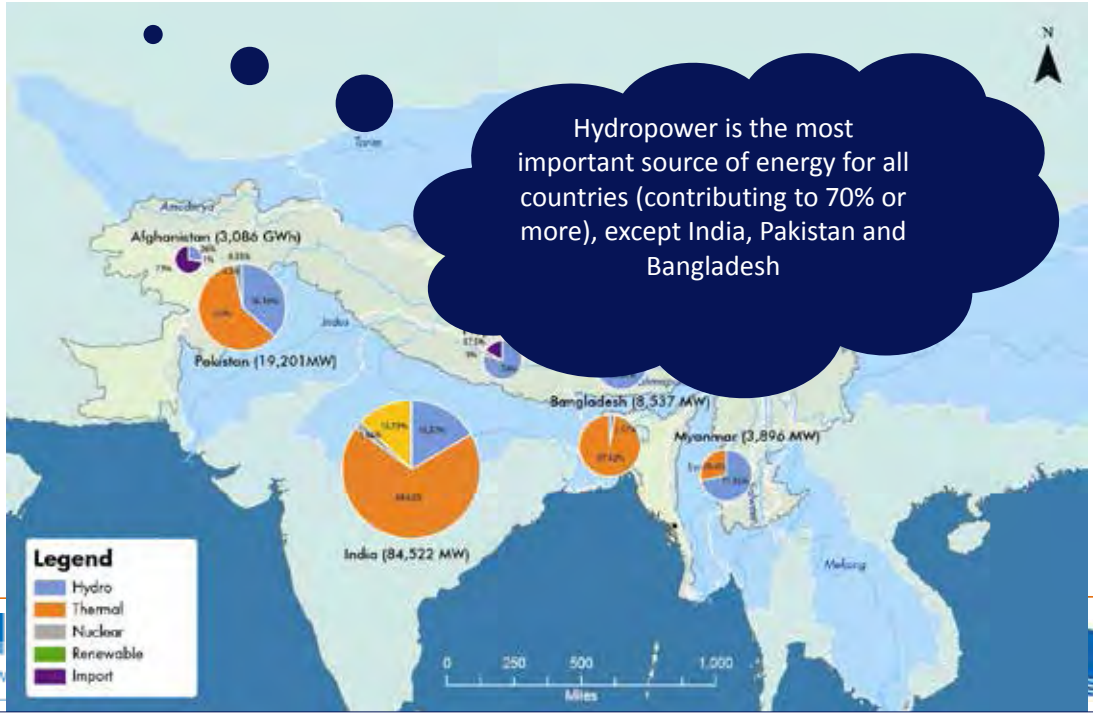
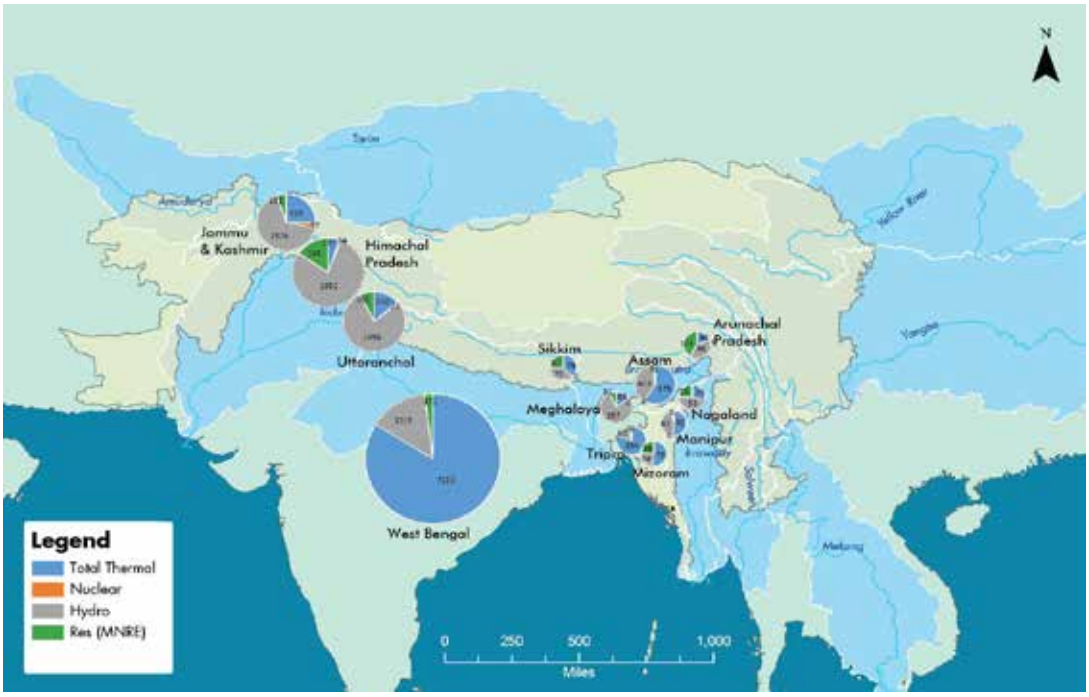



**Fig. 3.** Global Map of Irrigation Areas Version 5: Percentage of 5-min grid cell area that was equipped for irrigation around the year 2000 (Robinson projection)

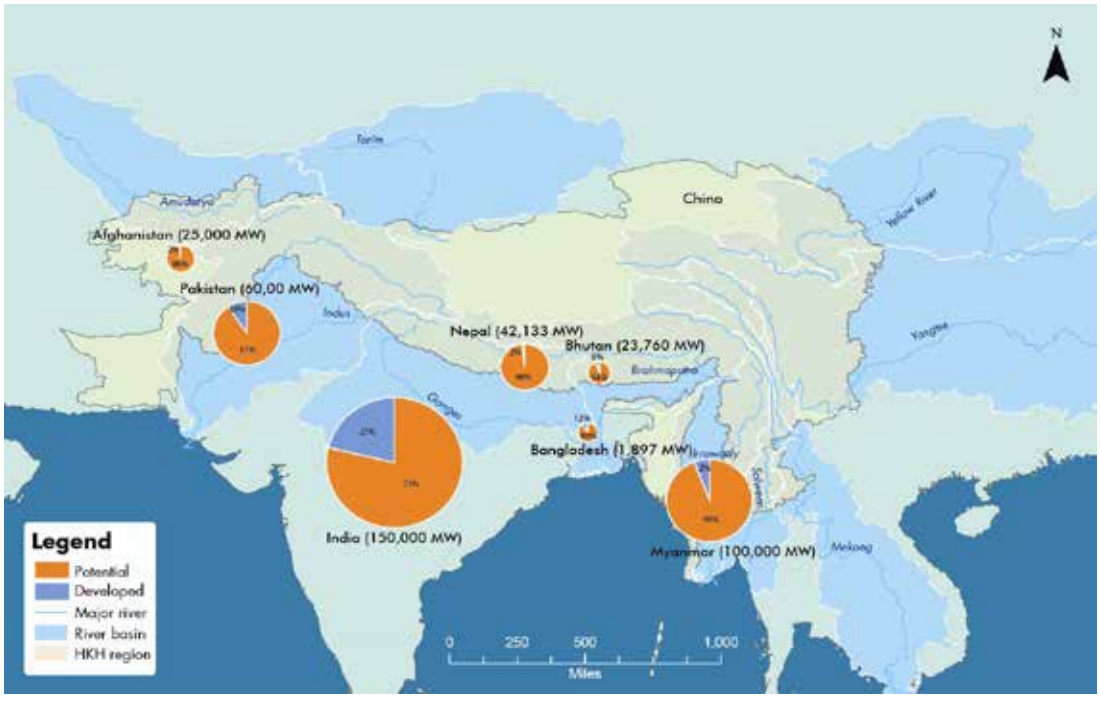
# Hydropower is one of the main energy sources in the HKH



Within India, hydropower is the main source in Indian Himalayan states (grey is hydro in this map)




Hydropower potential vs. developed: Lot of potential that is yet to be developed



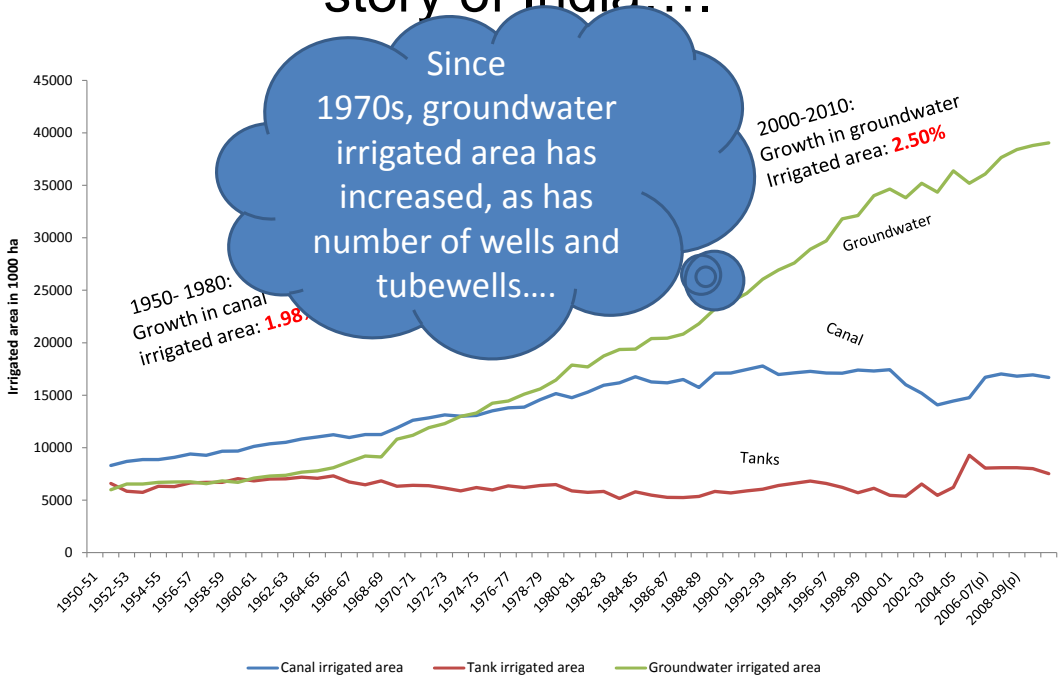
## The WEF question in mountains: How to provide energy security in an environmentally benign way?

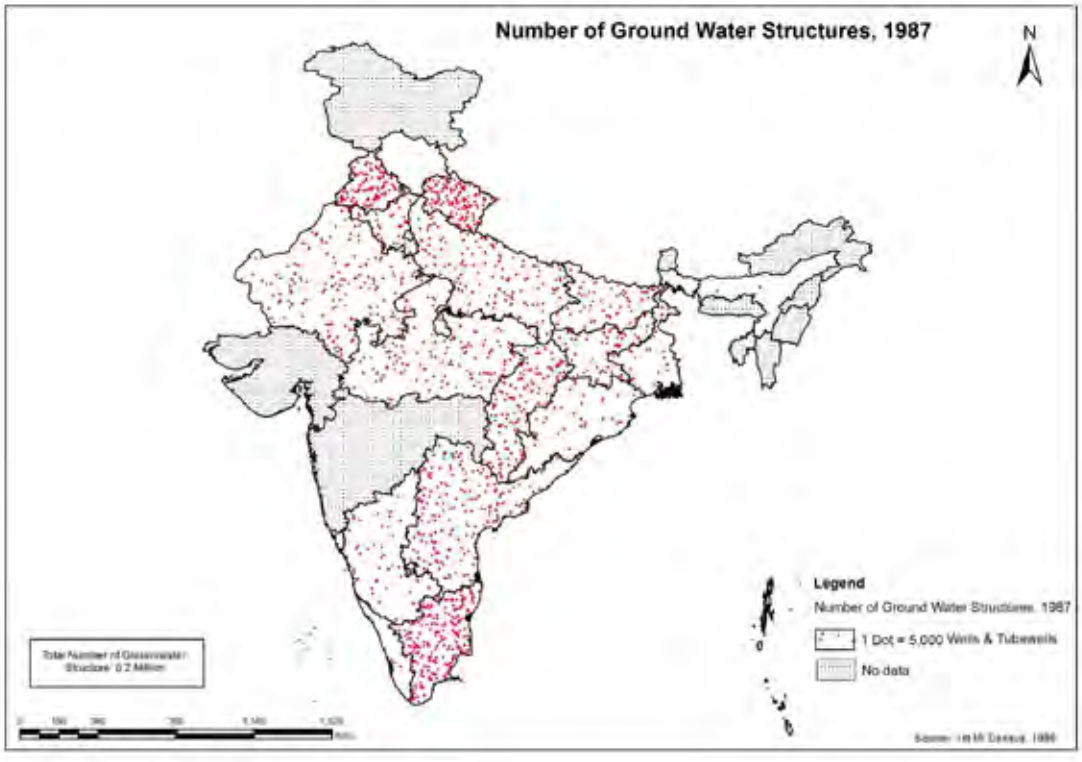
- Hydropower is most promising source in mountains, followed by solar and wind
- But there are at least two bottlenecks that prevents sustainable development of hydropower
  - Not enough attention is paid to issues of benefit sharing with local communities leading to protests and disruption of new projects
  - Current focus is on national energy security (or at best, bilateral trade), not enough attention to regional trade and cooperation on energy

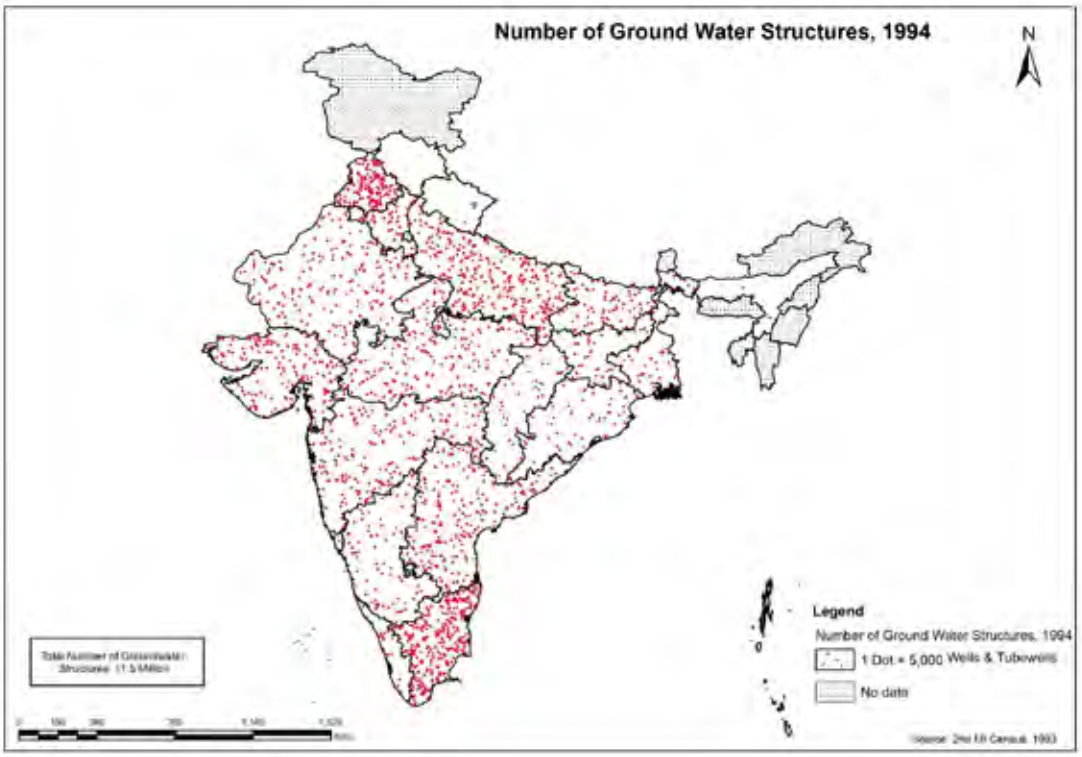
## Role of mountains in water-energy-food nexus

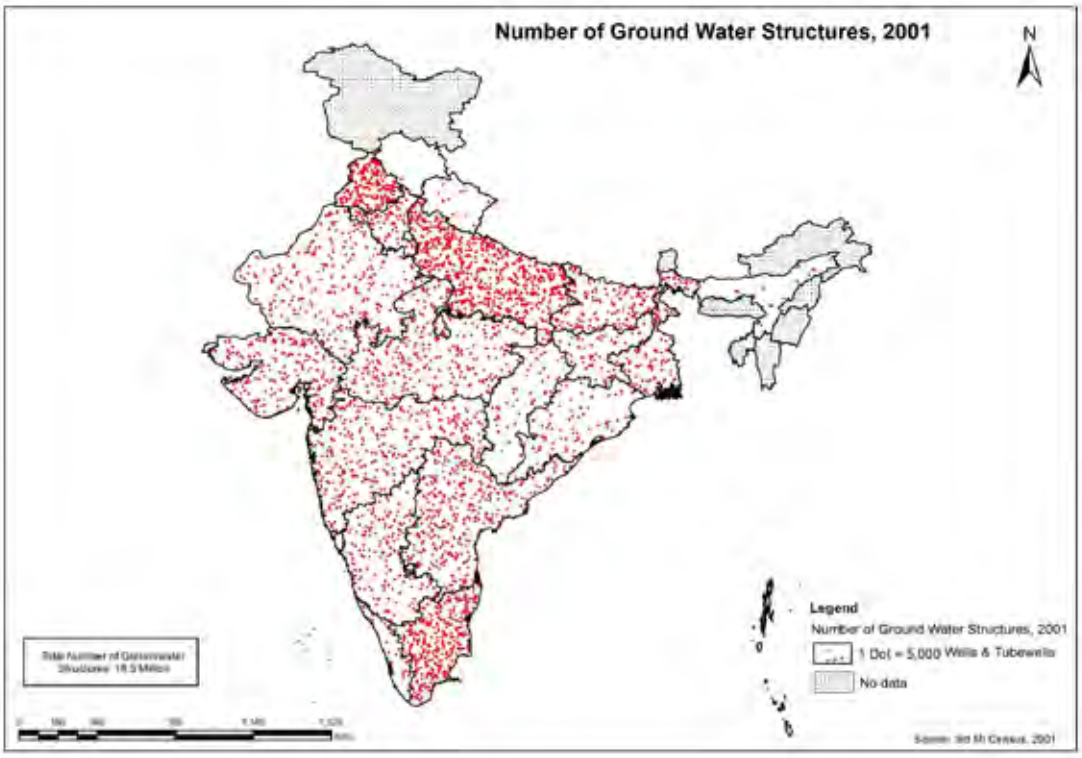
- Yet role of Himalayas is rarely discussed within the nexus debate
- And mountains continue to be neglected in policy discourses
- Same was true for groundwater in India a decade or two ago when it's role was not recognized to deleterious impacts

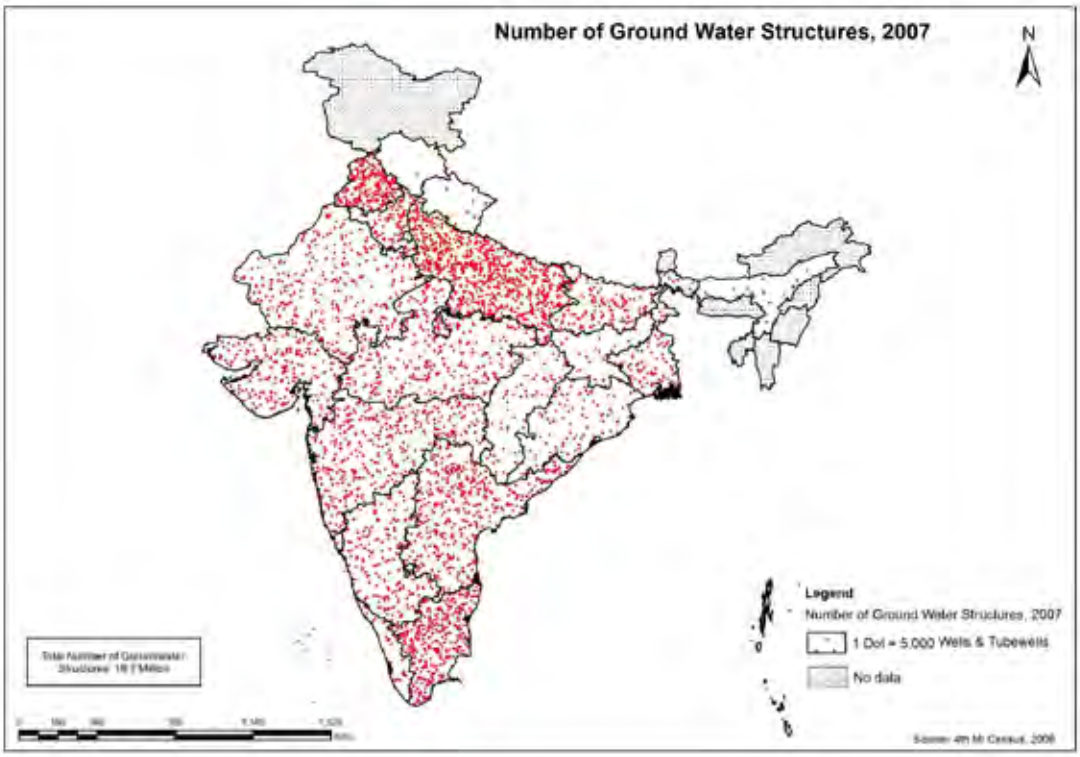
# The role of groundwater in irrigation story of India…



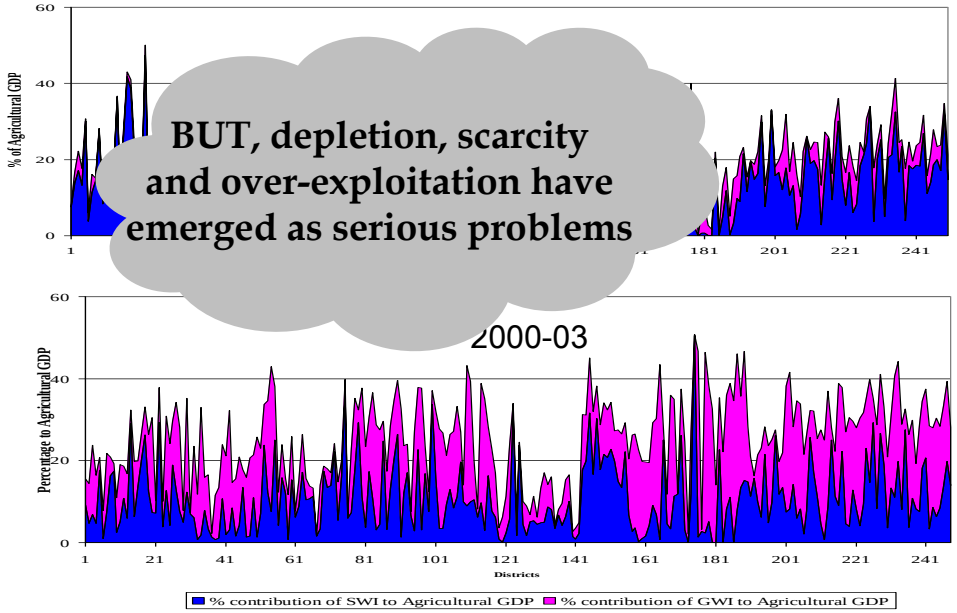




Number of Ground Water Structures, 1994
N
Legend
Number of Ground Water Structures, 1994
1 Dot = 5,000 Wells & Tubewells
No data


Number of Ground Water Structures, 2001
N
Legend
Number of Ground Water Structures, 2001
1 Dot = 5,000 Wells & Tubewells
No data



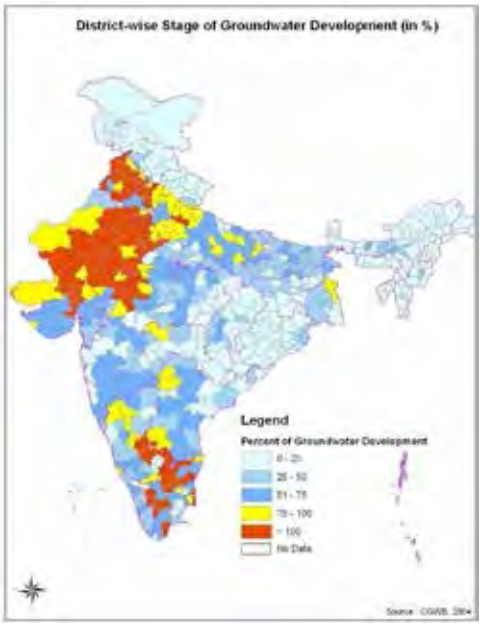

## Rising contribution of groundwater in agriculture




**BUT, depletion, scarcity and over-exploitation have emerged as serious problems**

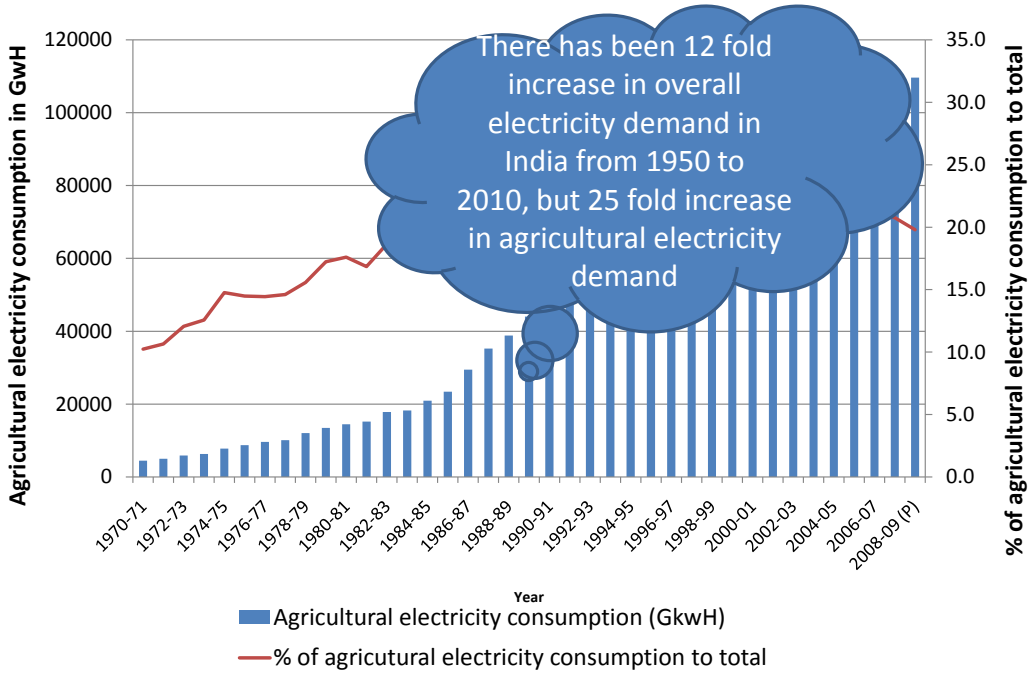
2000-03

## Leading to groundwater over-exploitation in many states……

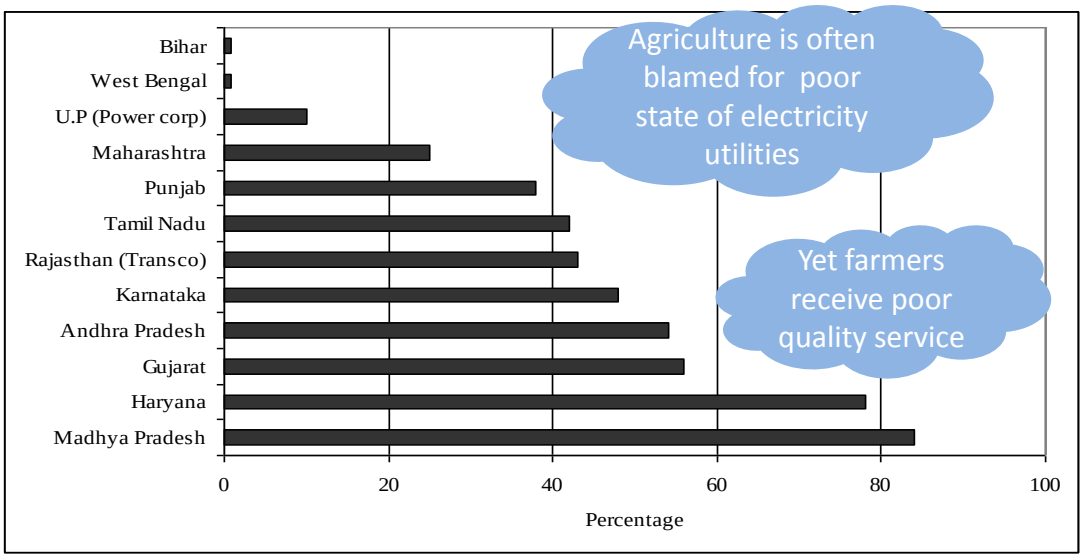



Districts depicted in red and yellow are the districts with over-exploitation problems

## Growth in electricity consumption in agriculture has outpaced growth in other sectors

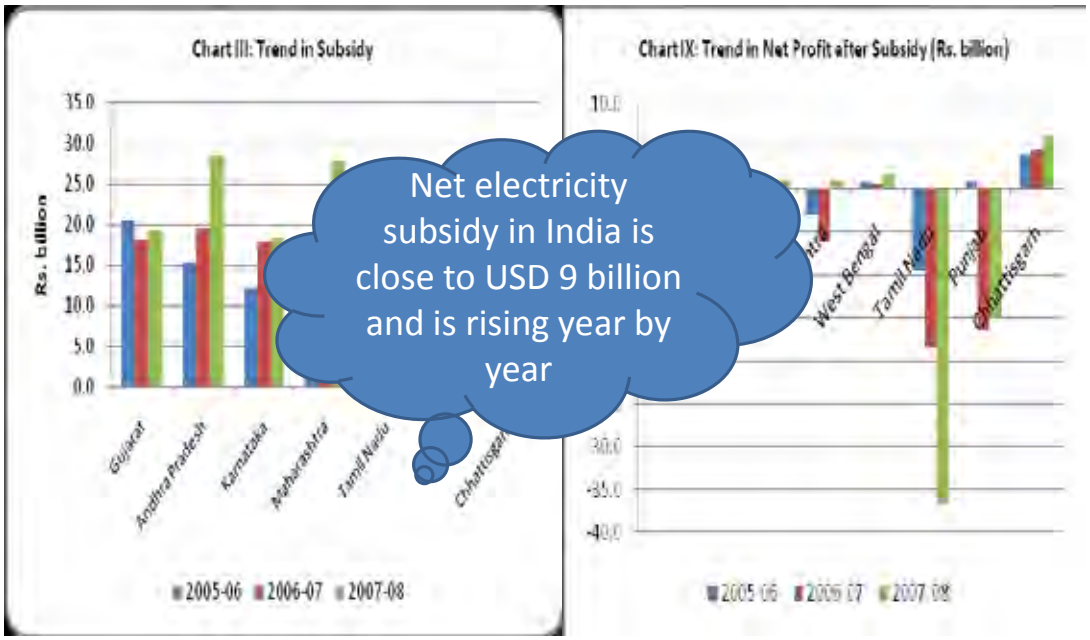


## Electricity subsidy as percentage of state fiscal deficits is very high in some states



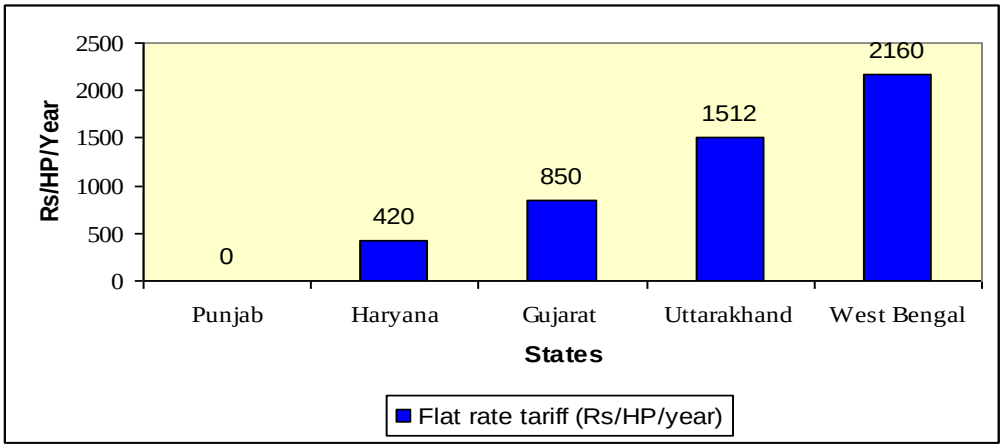

**BRISCOE, 2005, Data pertains to 2002**

## And requirement for subsidy keeps rising…



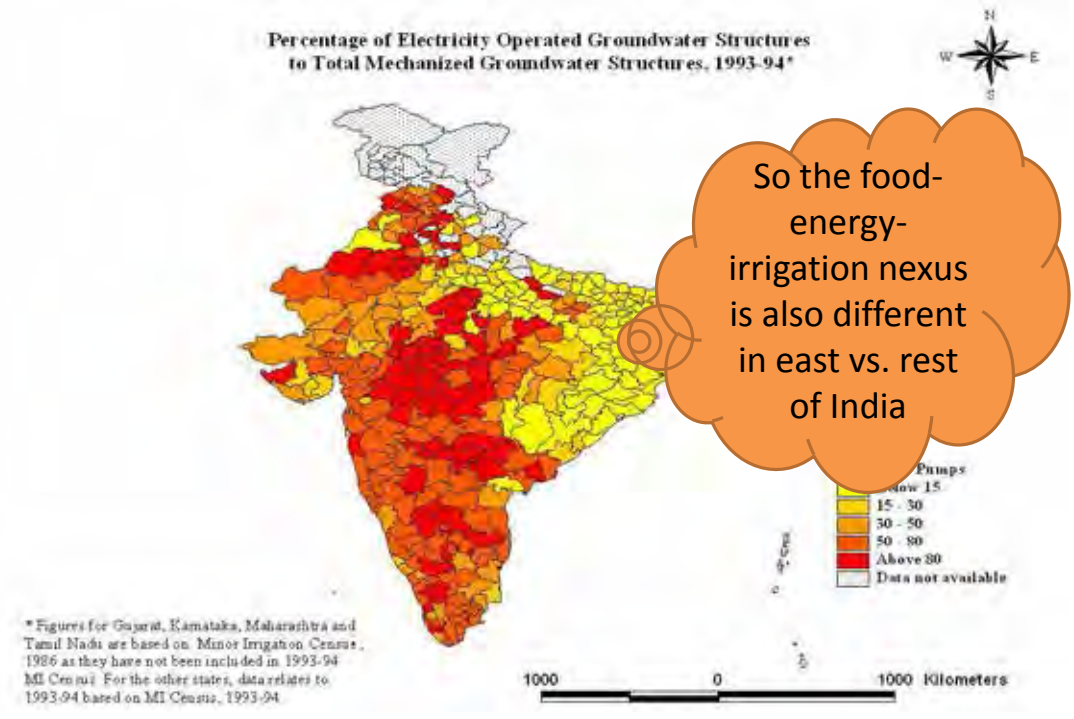

Source: ICRA

Farmers get free or highly subsidized electricity in most states (though not all).




Even when farmers pay for electricity, they pay it on a flat tariff basis. Only exception is the state of West Bengal where agricultural tubewells are Metered and farmers pay a time of the day (TOD) tariff

But then, there is the energy divide: Farmers in eastern India depend pre-dominantly on diesel pumps, while rest of India has electric pumps



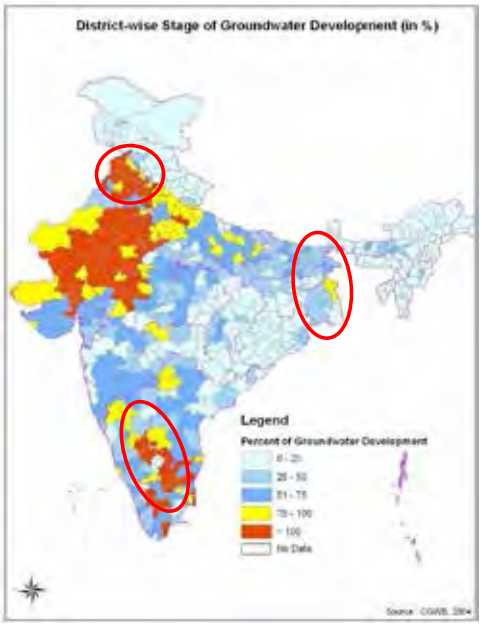

So the food-energy-irrigation nexus is also different in east vs. rest of India

## What is WEF nexus in groundwater?

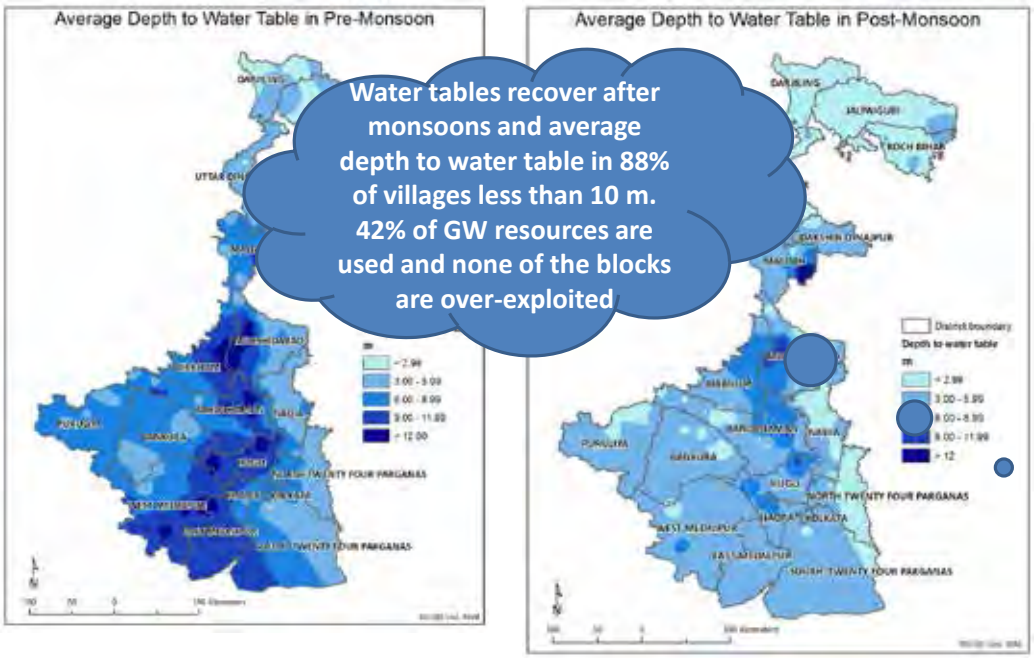
- India's irrigation sector is dependent on groundwater
- Much of this groundwater is pumped using electricity
- Groundwater use is more than sustainable recharge in most states leading to groundwater over-exploitation
- Electricity is subsidized in most (though not all) states
- This creates a nexus where one sector (agriculture) is dependent on unsustainable trends groundwater and electricity sectors

## How are different states in India managing this nexus through energy side interventions?

- West Bengal – Eastern India
- Punjab – Northern India
- Karnataka – Southern India

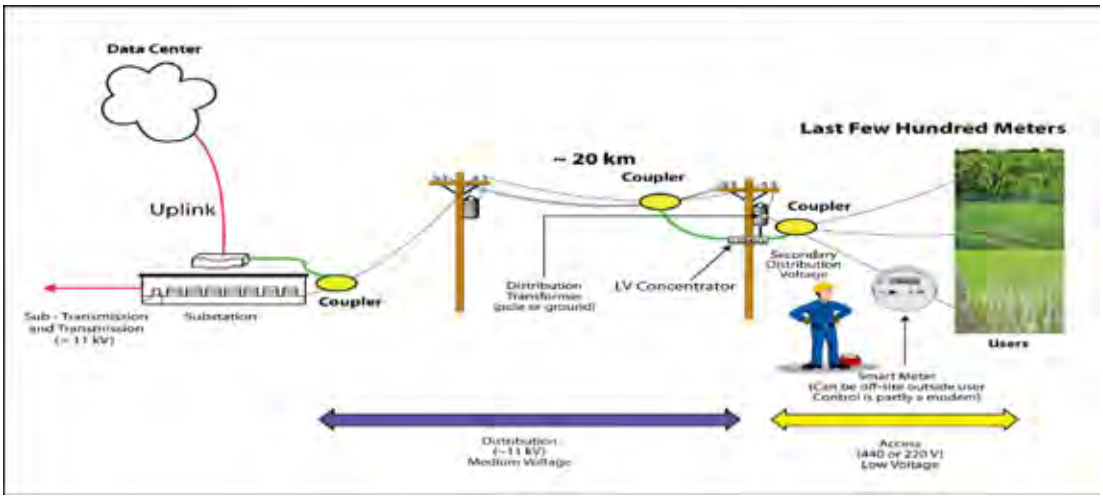


# West Bengal: Alluvial aquifers, low groundwater use and high recharge




# Managing the nexus in West Bengal through Universal TOD and hi-tech metering

- Universal Time of the Day (TOD) metering of all agricultural tubewells in the state. Till March 2010, 90% TWs metered
- High tech metering with remotely read meters



## Impacts of metering

**Pump owners:**

**Largely winners**

- ☺ Same hours of pumping for own use– Less electricity bill
- ☺ Less hour of selling water – Higher or same revenue
- ☺ Higher bargaining power vis-à-vis water buyers
- ☺ Win – win situation

**Water buyers:**

**Losers**

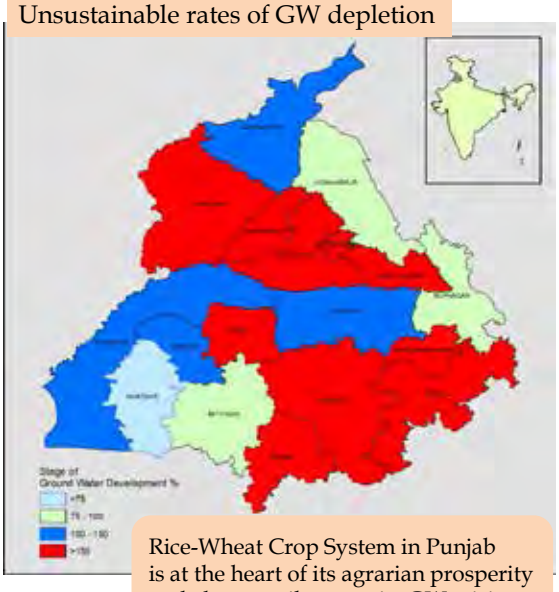
- ☹ Increase in water charges by 30-50%
- ☹ Lesser hours sold by pump owners
- ☹ Adverse terms & condition of buying water

# Groundwater use efficiency: Winner

- ☺ Increased adoption of plastic pipes for conveyance
- ☺ Better maintenance of field channels
- ☺ Construction of underground pipelines
- ☺ But will it save water?

## Food-irrigation-energy nexus in Punjab

Unsustainable rates of GW depletion



Rice-Wheat Crop System in Punjab is at the heart of its agrarian prosperity and also contributes to its GW crisis

Alluvial aquifers and low rainfall

Rice Wheat crop combination matches over-exploited zones in Punjab

## Steps taken by Punjab to manage the nexus

**Feeder segregation**

- Separate elec… …onsumers
- Agricultur… …y/day

**HVDS**

- High Vo…
- 2-3 pu… …r to provide better quali…

These measures are reasonably successful in improving quality of electricity to farmers, but severe rationing pushes them to use diesel. Fiscal discipline within the utilities has improved. Has not affected crop yields adversely yet.

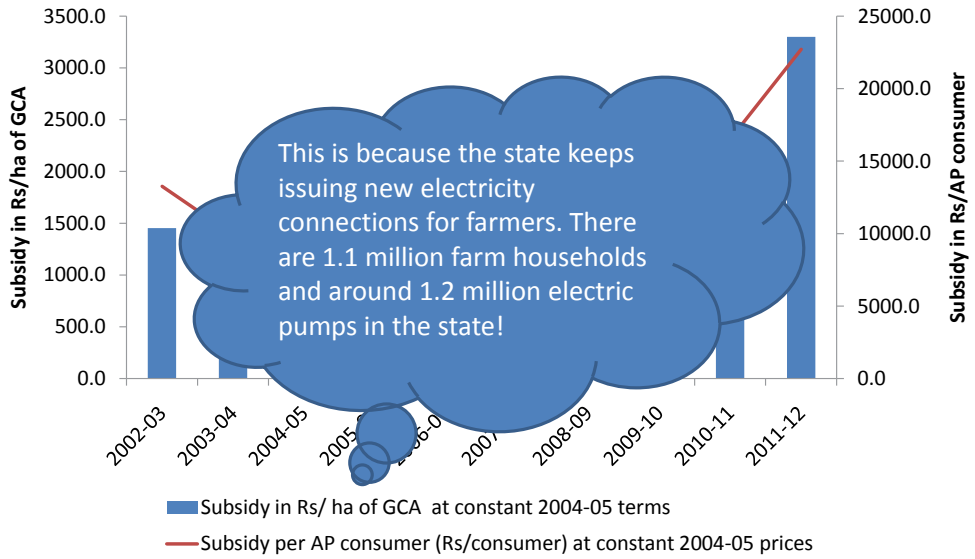
**Energy audits**

- Metering at feeder level as farmers resist tubewell meters
- Improved methods of calculating ag. power consumption

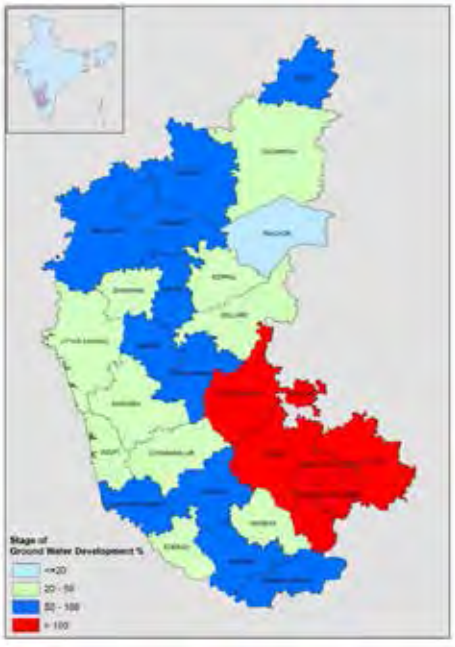
## Transmission and distribution losses have reduced marginally…

| Year | T&D loss level fixed by the Commission | T&D loss level reported by the Board | T&D losses based on AP consumption approved by the Commission |
|---|---|---|---|
| 2004-05 | 23.25 | 24.27 | 24.59 |
| 2005-06 | 22 | 25.07 | 25.38 |
| 2006-07 | 20.75 | 23.92 | 24.25 |
| 2007-08 | 19.5 | 22.53 | 25.12 |
| 2008-09 | 19.5 | 19.92 | 22.21 |
| 2009-10 | 22 | 19.5 | 22 |
| 2010-11 | 20 | 18 | 19.5 |
| 2011-12 | 19 | | |
| 2012-13 | 18 | | |

# But subsidy burden for agricultural consumption keeps rising….

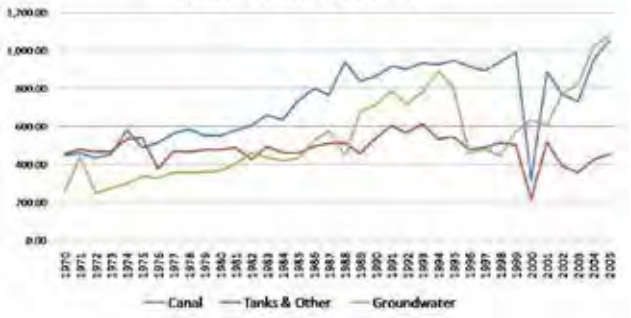


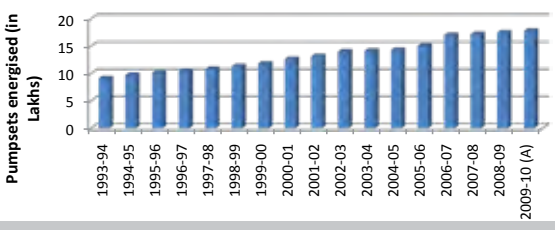

# Food-energy-irrigation nexus in Karnataka



Hard rock aquifers and low rainfall

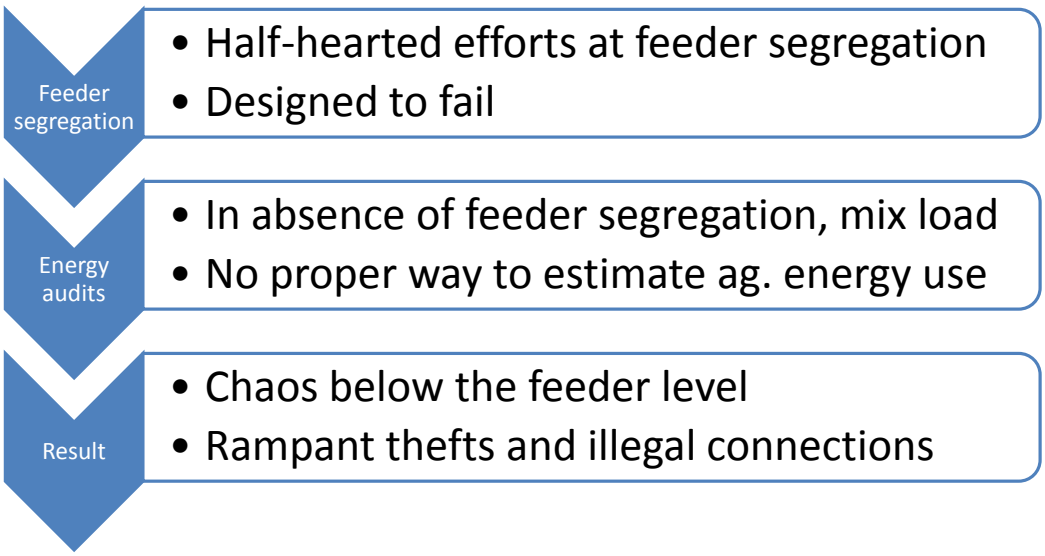
Area under groundwater irrigation continues to rise…




As does number of electric pumpsets..

## (Mis) managing Food-Energy-Irrigation Nexus in Karnataka




## Conclusions

- While the broad issues are same, different states in India have managed this nexus differently
- Ranging from very hi-tech and text-book solution in West Bengal, to second best solution in Punjab to utter anarchy in Karnataka
- Much depends on political will and overall governance at state level since both water and electricity are state subjects in India

# Question for group discussion

- Context specificity defines both the nexus problem and dictates its solution. What kind of nexus issues do we encounter in regions we know best and how can they be solved or are being solved/managed?

# Thank You

aditi.mukherji@icimod.org

## Annex IX: **Day II Presentations at ICIMOD by Dr David Molden and Dr Eklabya Sharma**


## Regional Intergovernmental Learning and Knowledge Centre

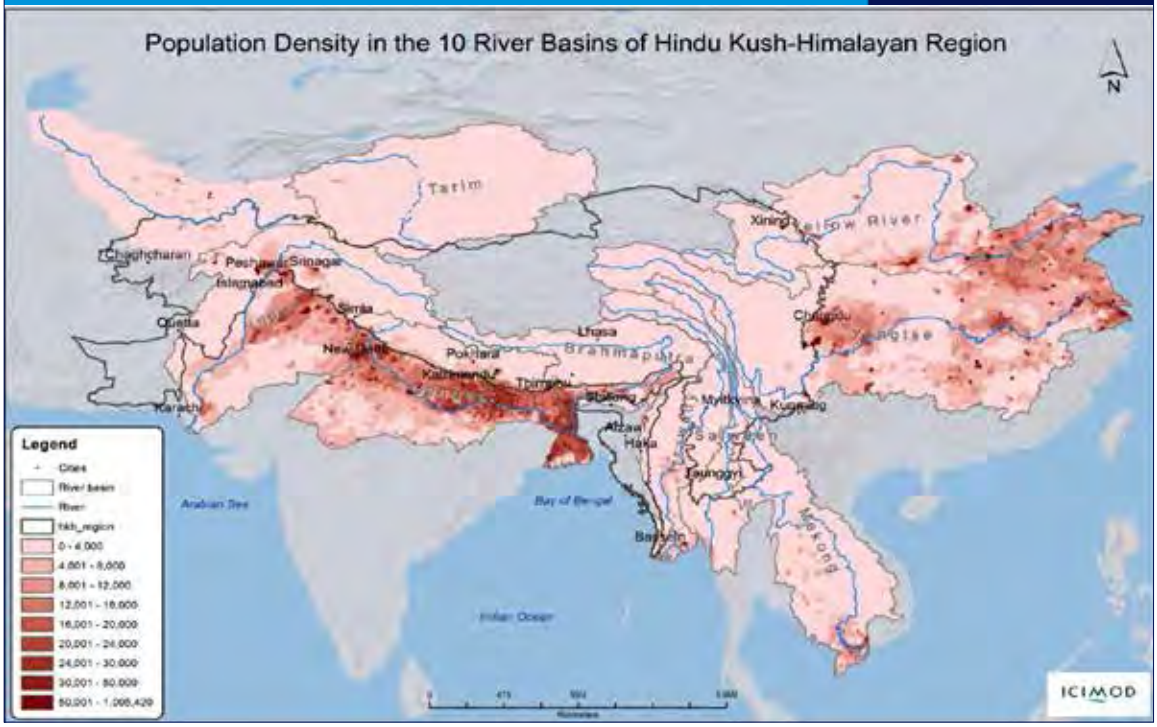
ICIMOD


**210 million people in the HKH**

**1.3 billion people downstream**

## Basins support some of the most populated areas on the globe

ICIMOD



# The Hindu Kush Himalayas: More than 1,000 living languages

# Poverty in the Himalayan Region High Outmigration

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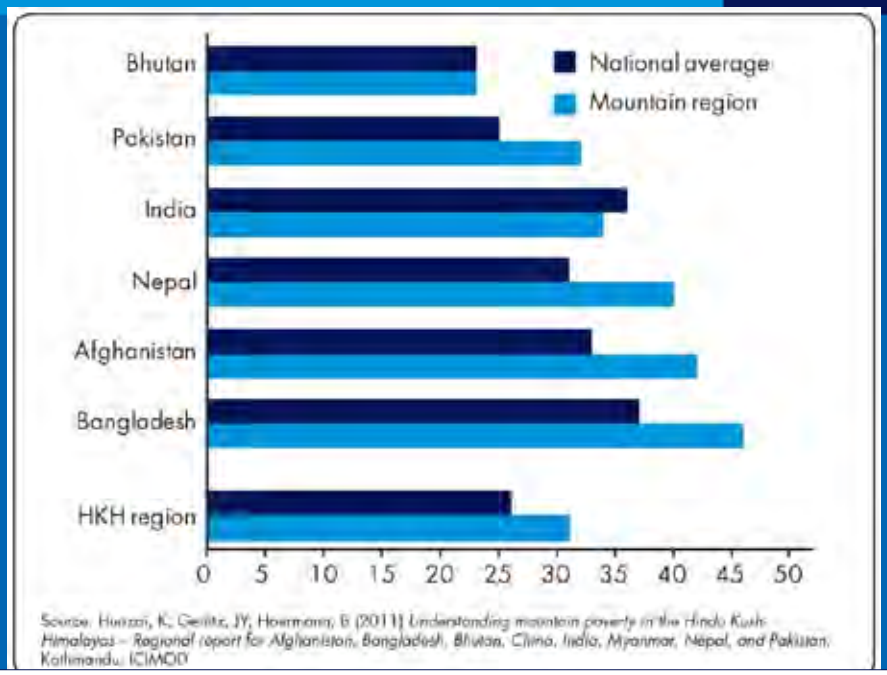
FOR MOUNTAINS AND PEOPLE



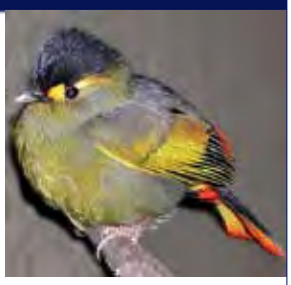

Source: Hurzeler, K., Gerlitz, JY., Hoermann, B. (2011) *Understanding mountain poverty in the Hindu Kush-Himalayas – Regional report for Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan.* Kathmandu: ICIMOD

# Still discovering new species…

ICIMOD

Dracula fish
*Myanmar (2009)*

Leaf Deer
*Myanmar* (1999)



Bugun Liocichla
*India (2006)*

Smith's Litter frog
*Assam, India (1999)*

Orange spotted snakehead
*Assam, India (2000)*

Nepalese autumn poppy
*Nepal (collected but not identified as new until 1994)*

# Agricultural biodiversity Important for Future Food Security

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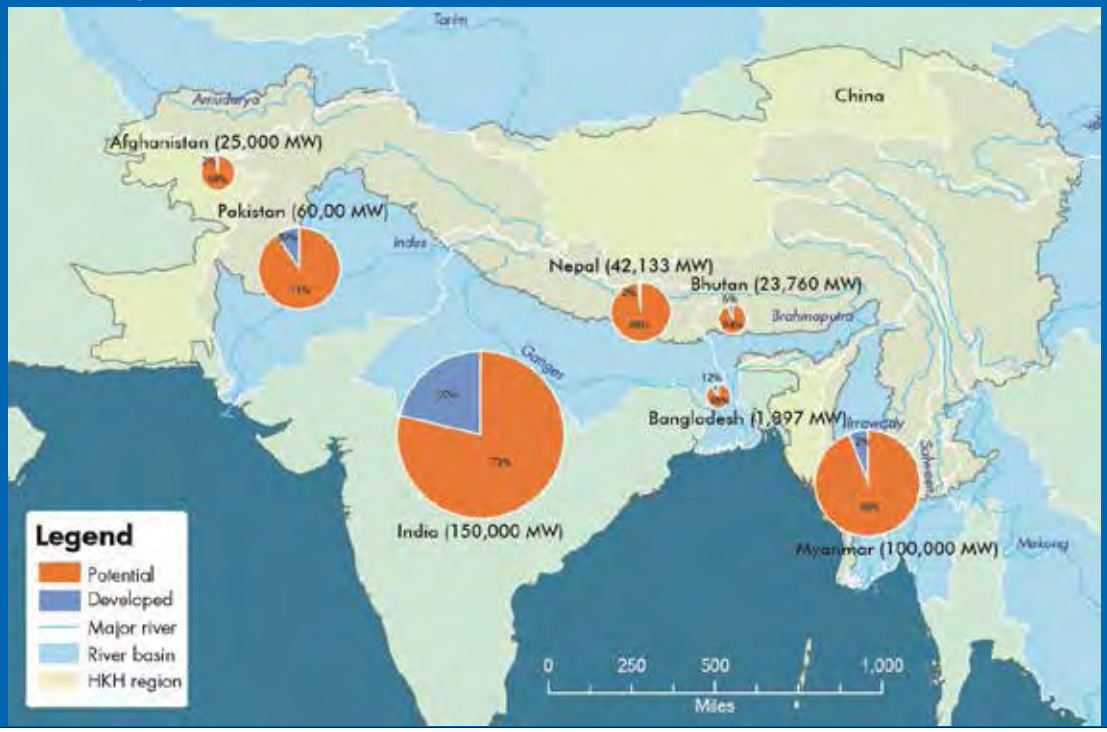
FOR MOUNTAINS AND PEOPLE


## Hydropower development relative to its potential in HKH

ICIMOD




## Water Towers of Asia

### 1.3 Billion People Downstream

ICIMOD

www.icimod.org

## What is happening to the cryosphere?

# Tracking changes in the Glaciers

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FOR MOUNTAINS AND PEOPLE

=> Significant Data Gap Exists – snow, ice, permafrost, black carbon

# Glaciers in the HKH region

**Glacier Area in HKH: about 60,000 km²**


| Basins | Count | Area (km²) |
|---|---|---|
| Amu Darya | 3,277 | 2,566 |
| Indus | 18,495 | 21,193 |
| Ganga | 7,963 | 9,012 |
| Brahmaputra | 11,497 | 14,020 |
| Irrawaddy | 133 | 35 |
| Salween | 2,113 | 1,352 |
| Mekong | 482 | 234 |
| Yangtze | 1661 | 1,660 |
| Yellow | 189 | 137 |
| Tarim | 1,091 | 2,310 |
| Interior | 7,351 | 7,535 |
| Total | 54,252 | 60,054 |

**Glacier Cover in HKH: 1.43%**

## Himalayan glaciers are shrinking according to many studies

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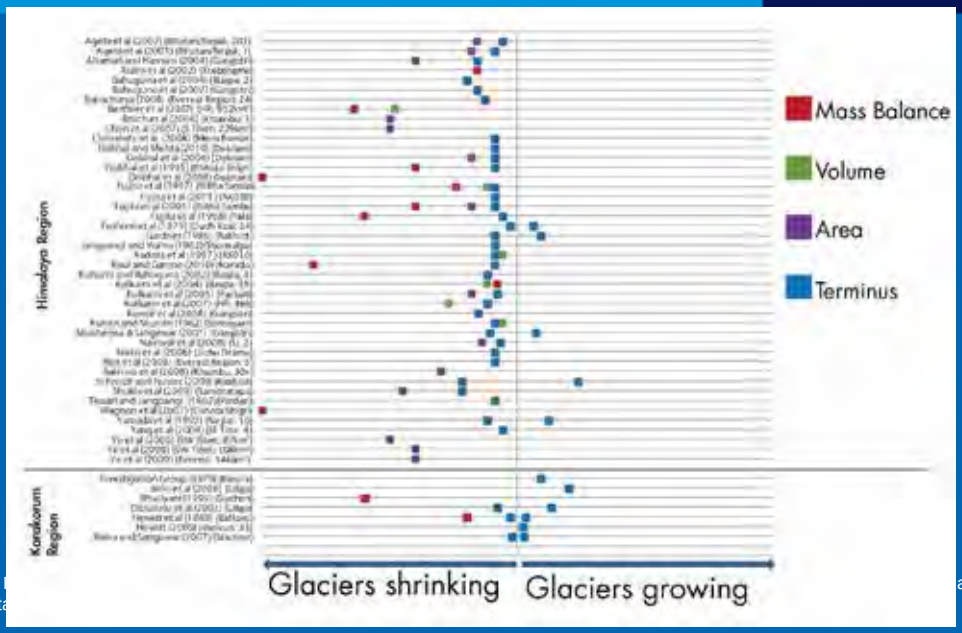


Note: I … acier; U=Utta…

Source: Miller et al. (2011)

## Black Carbon Mitigation Multiple Benefits

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FOR MOUNTAINS AND PEOPLE

Multiple Benefits of Mitigation:
- Less temperature rise
- Reduced glacial and snow melt
- Health benefits
- Crop Yields

**Nov - April Sky**

## Black Carbon

- Brick kilns
- Cook-stoves
- Open burning
- Diesel vehicles
- Forest fires

## Water Towers of Asia

1.3 Billion People Downstream

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### What will happen to water resources?

# Contributions of Glacier and Snow Melt to Runoff 1998-2007

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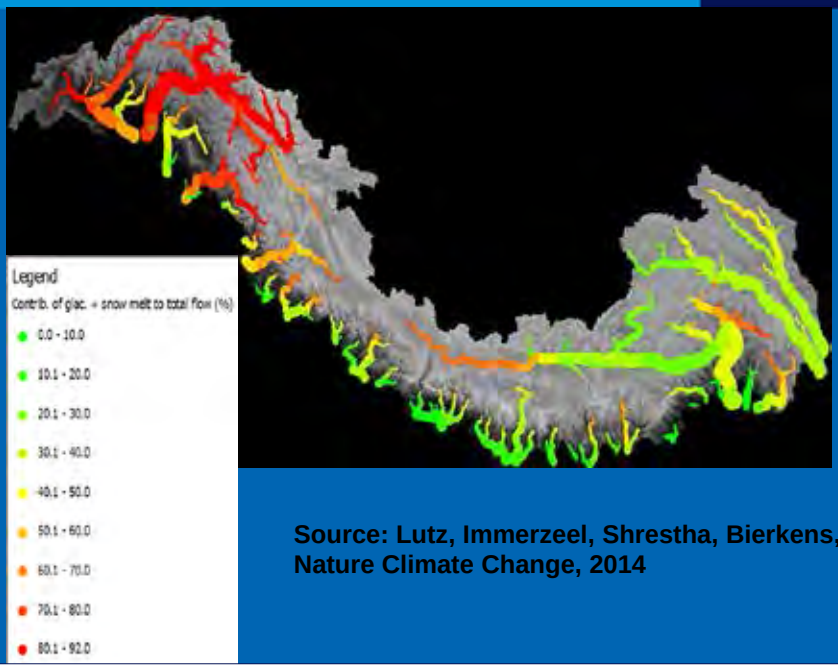


**Source: Lutz, Immerzeel, Shrestha, Bierkens, Nature Climate Change, 2014**

# Impacts on local community: Loss of water source

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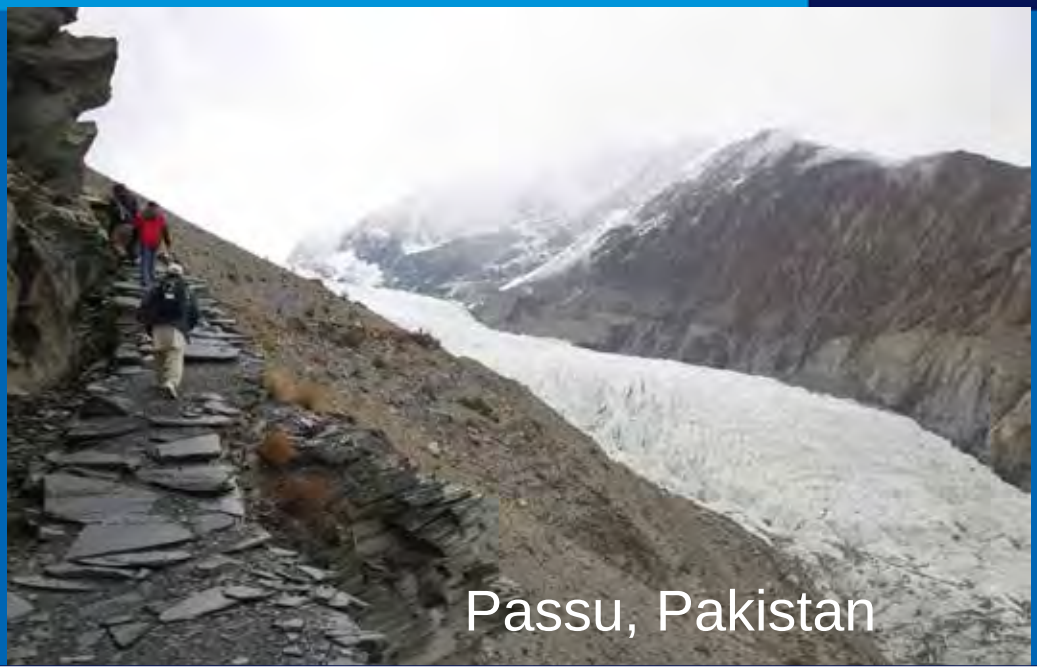
FOR MOUNTAINS AND PEOPLE



# Disaster risk and damage - increasing

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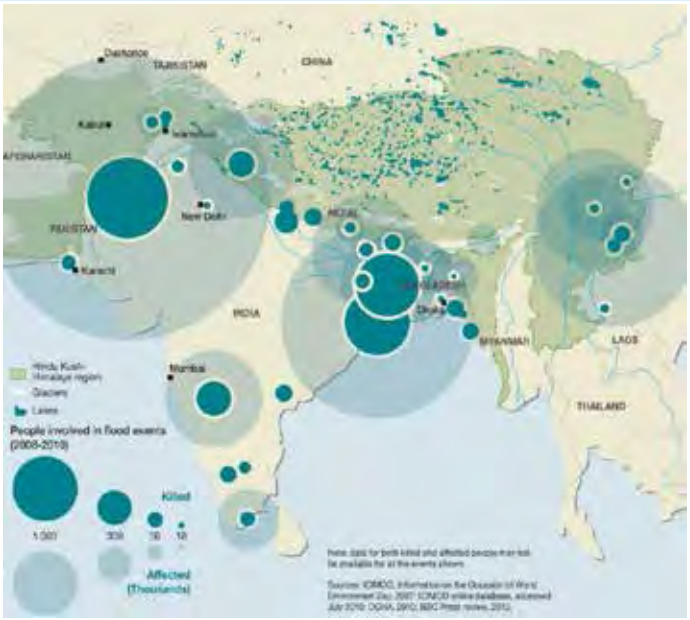




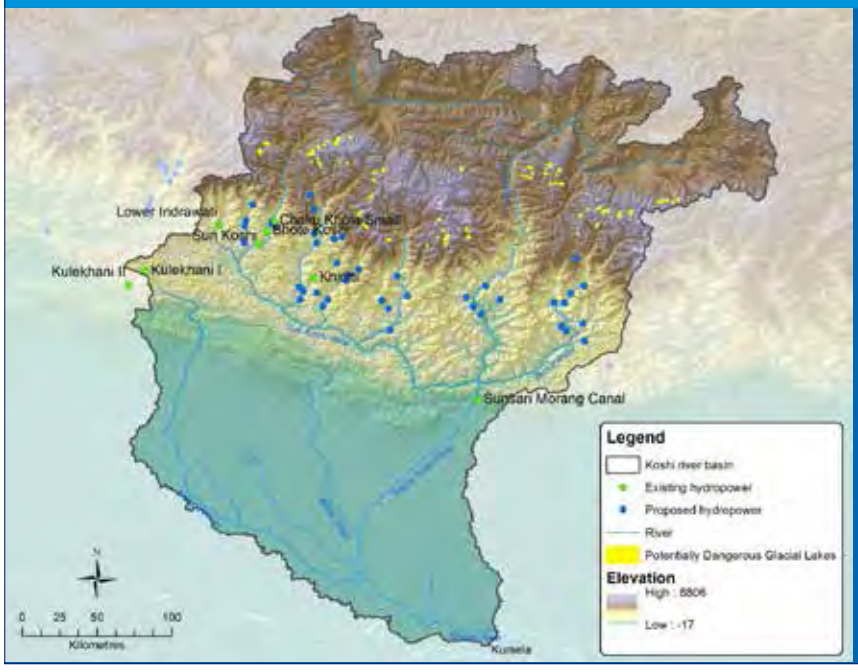
## Sun Koshi Landslide 2 August 2014

ICIMOD

## Koshi Basin: GLOFs and Hydropower

ICIMOD

FOR MOUNTAINS AND PEOPLE




China, Nepal, India

Trans-Boundary Approaches Are Critical

## Change Brings Opportunities

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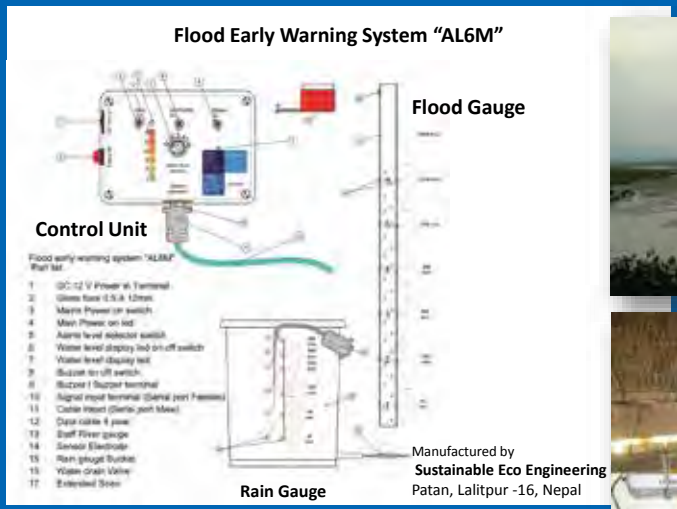
- High valued products and v chains
- Benefit Sharing, REDD+
- Ecotourism
- Remittances
- Sustainable energy
- Cross Border Scientific Collaboration
- Upstream-Downstream Linkages

## Low-tech, low cost, community-based flood early warning system in Assam

ICIMOD

FOR MOUNTAINS AND PEOPLE




# Forest Fire Detection and Monitoring

SERVIR HIMALAYA


# The International Centre for Integrated Mountain Development

ICIMOD

- A regional mountain knowledge, learning and enabling centre devoted to sustainable mountain development for mountains and people
- **Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan**
- www.icimod.org

**The Hindu Kush-Himalayan Region**


**Extends over 3500 km from Afghanistan to Myanmar and Home to 200 million People**

# Mission

ICIMOD

To enable sustainable and resilient mountain development for improved and equitable livelihoods through knowledge and regional cooperation

# Governance

ICIMOD

- Board of Governors – representatives of 8 Regional Member Countries
- Programme Advisory Committee – 7 Independent Board Members
- ICIMOD Support Group – made up of financial contributors

## Linking Science-Policy-Practice

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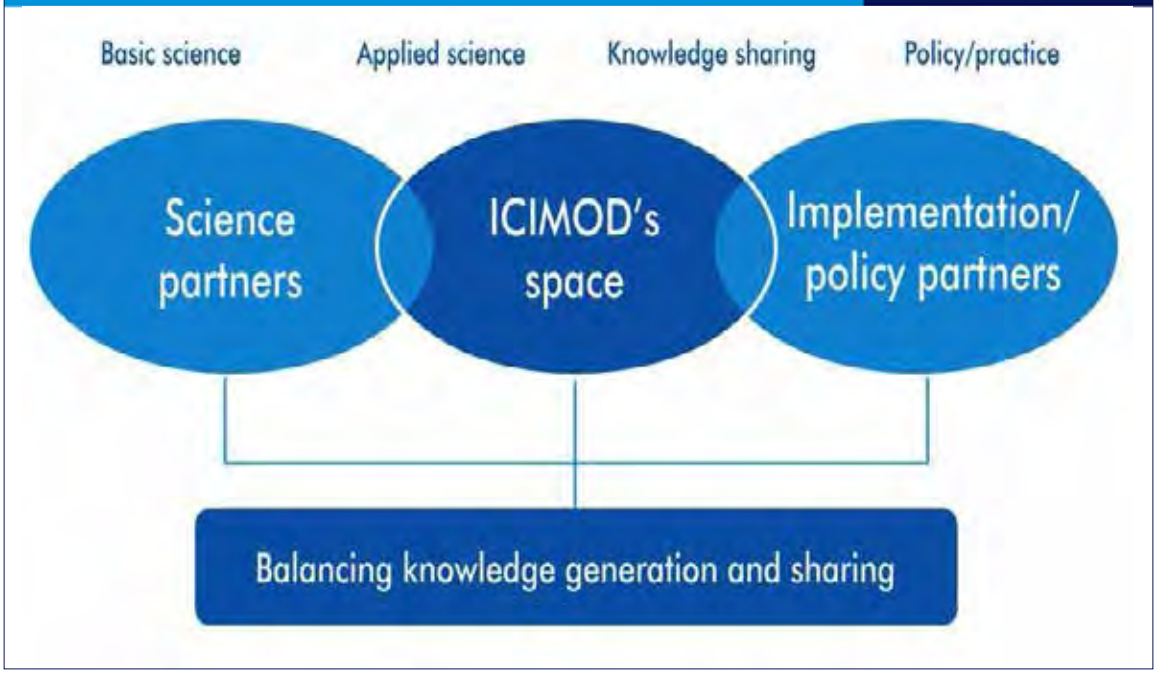


## Thank You

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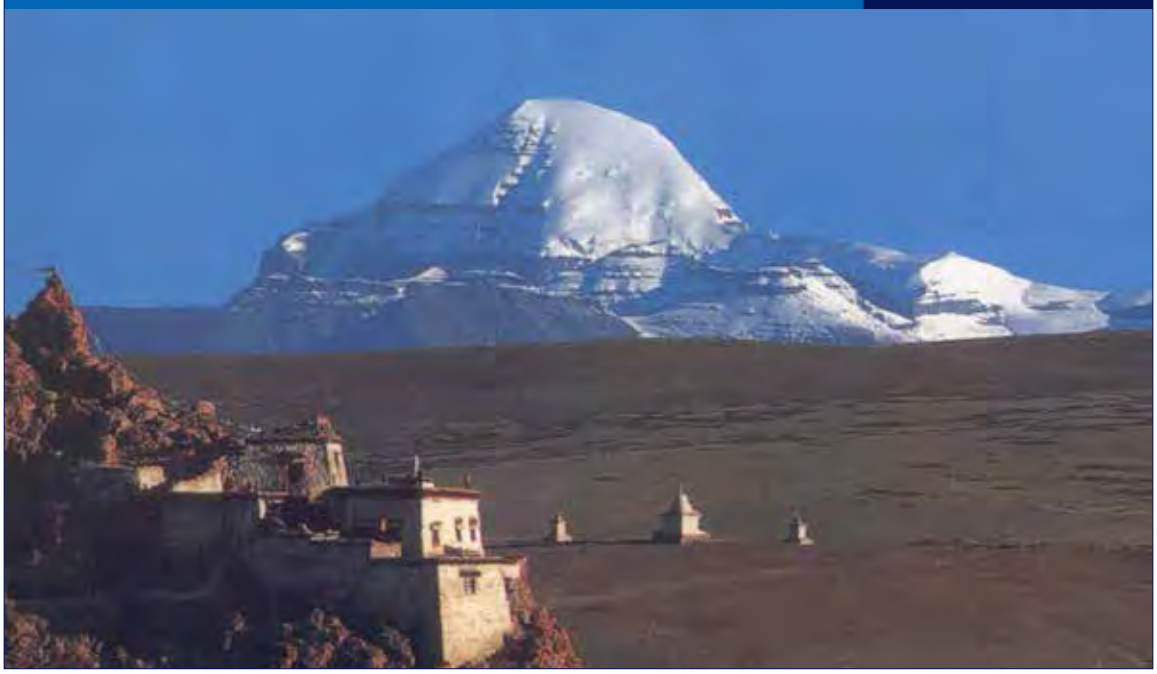

## ICIMOD's Strategic Framework

# Responding to Mountain Challenges in the Hindu Kush-Himalayas – ICIMOD's Regional Programmes

Eklabya Sharma

International Centre for Integrated Mountain Development

Kathmandu, Nepal

ICIMOD

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## Regional Programmes

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1) Adaptation to Change
2) Transboundary Landscapes
3) River Basins
4) Cryosphere and Atmosphere
5) Mountain Environment Regional Information System
6) Himalayan University Consortium

Theme: Livelihoods, Ecosystem Services, Water & Air, Geospatial Solutions

# Transboundary Landscapes & River Basin Approaches

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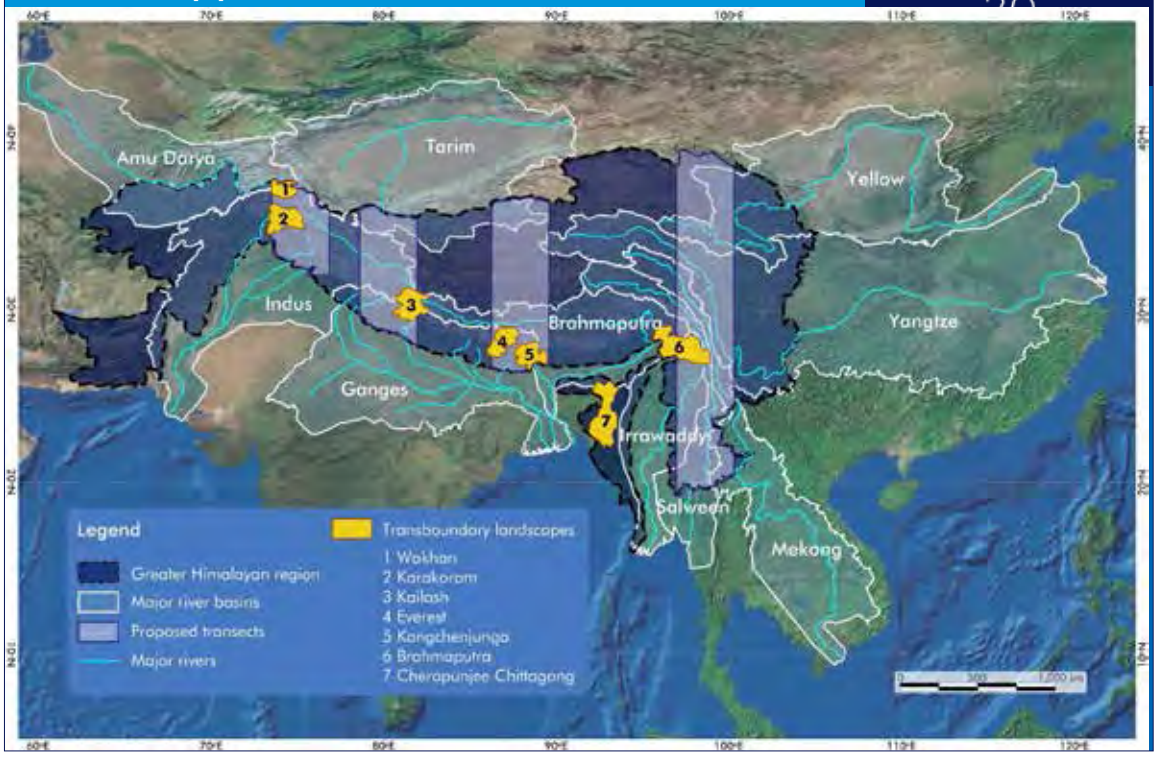


# Adaptation to Change Programme

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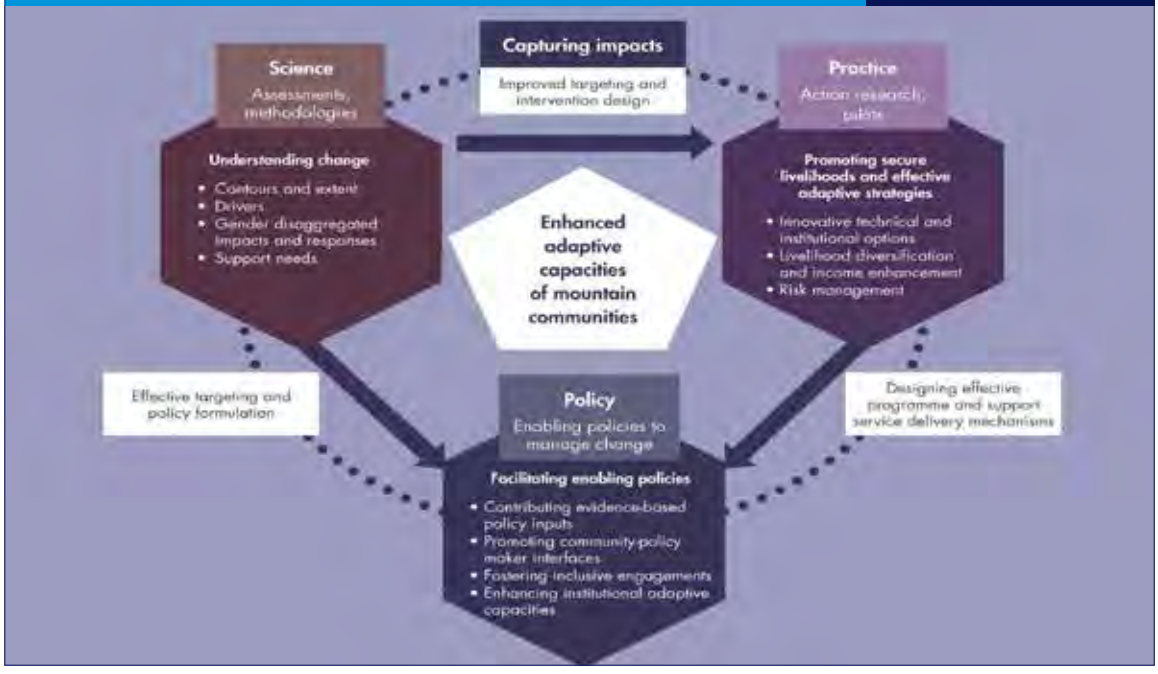
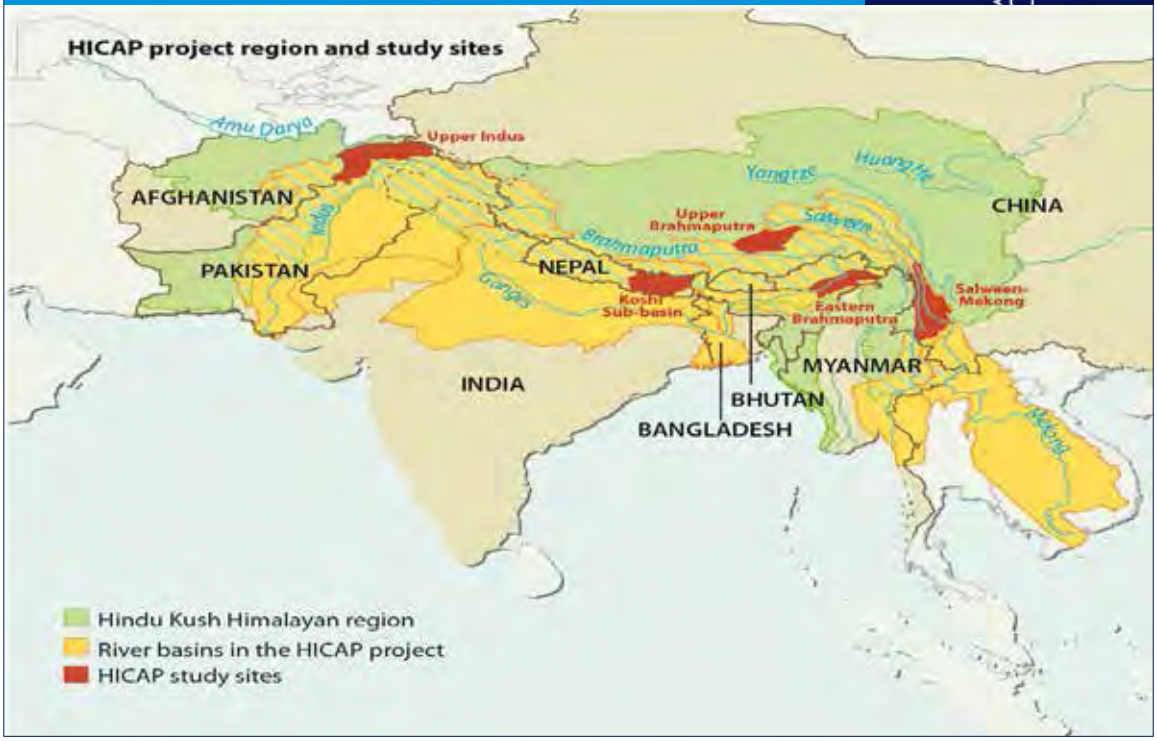


## Himalayan Climate Change Adaptation Programme

ICIMOD 30




## Opportunities: High Valued Mountain Products & Value Chains

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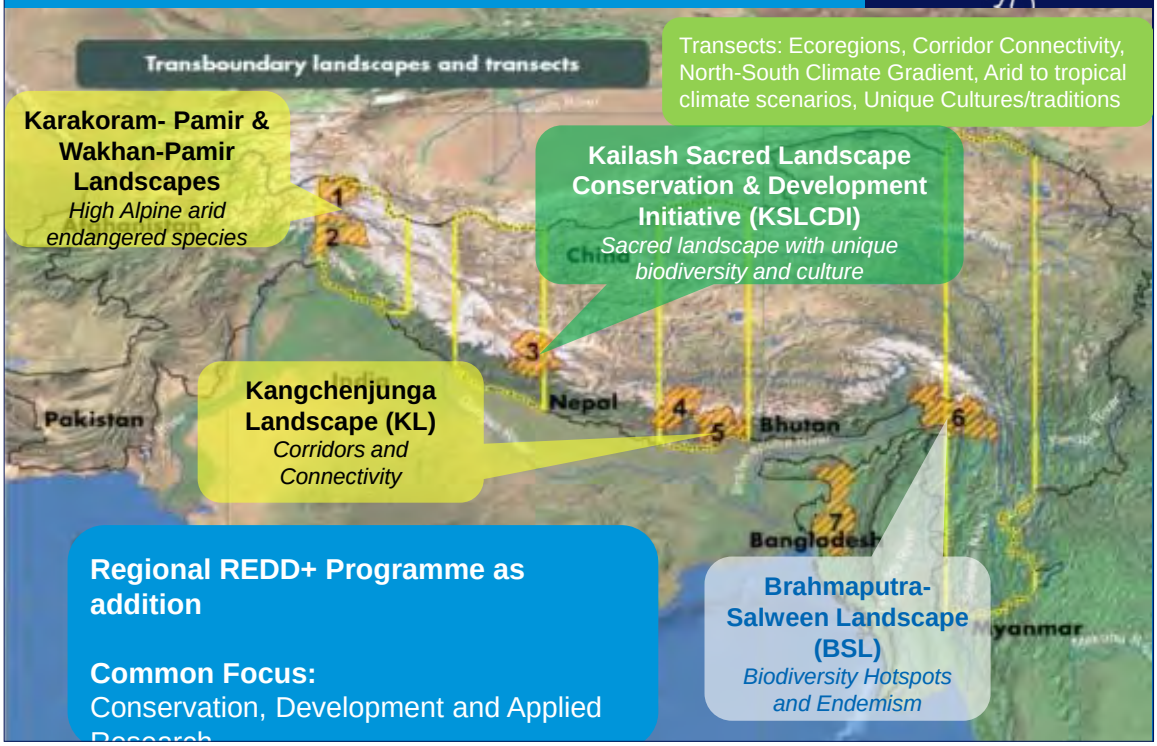
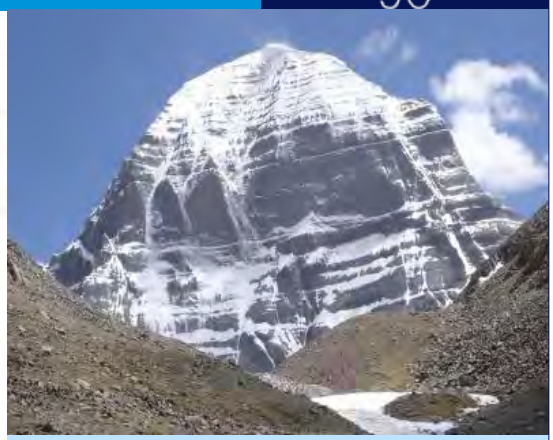
# Transboundary Landscape Programme




# Kailash Sacred Landscape
*China-India-Nepal*

- Addressing scientific uncertainties
- Regional cooperation framework for research
- Capacity building and information sharing

## River Basin Programme
### Mountains and Downstream Region Linkages – Koshi River Basin

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Transboundary Approaches are Critical in River Basin Management; Balancing Hydropower and Environment; Infrastructure Planning

## Contributions Glacier and Snow Melt to Runoff 1998-2007

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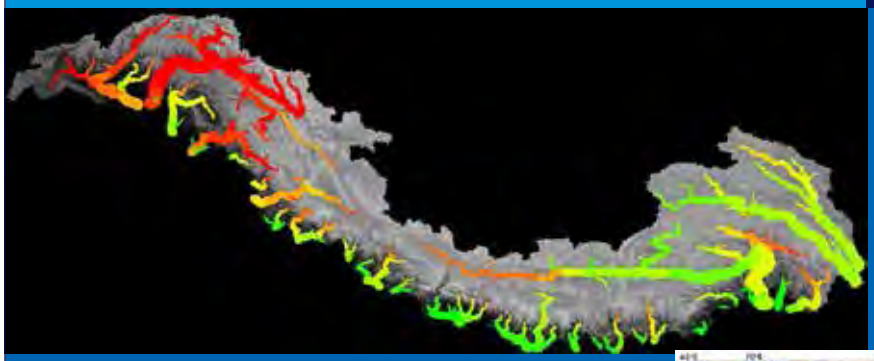

Seasonality, critical moments
Source: FutureWater, ICIMOD, 2013

Enhance adaptive capacities & climate resilience of the vulnerable in the river basins of HKH, through development of robust evidence to inform people-centred and gender sensitive climate change adaptation policies & practices.

# Regional Flood Information System
## HKH-HYCOS

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'Making Information Travel Faster Than Flood Waters'


**Establishment of a Regional Flood Information System in the HKH-Region -** Timely exchange of flood data and information through an accessible and user friendly platform

HKH-HYCOS is a vehicle for technology transfer, training, and capacity building

# Cryosphere Programme
## Glaciers, GLOFs, Permafrost, Snow, Hydrology

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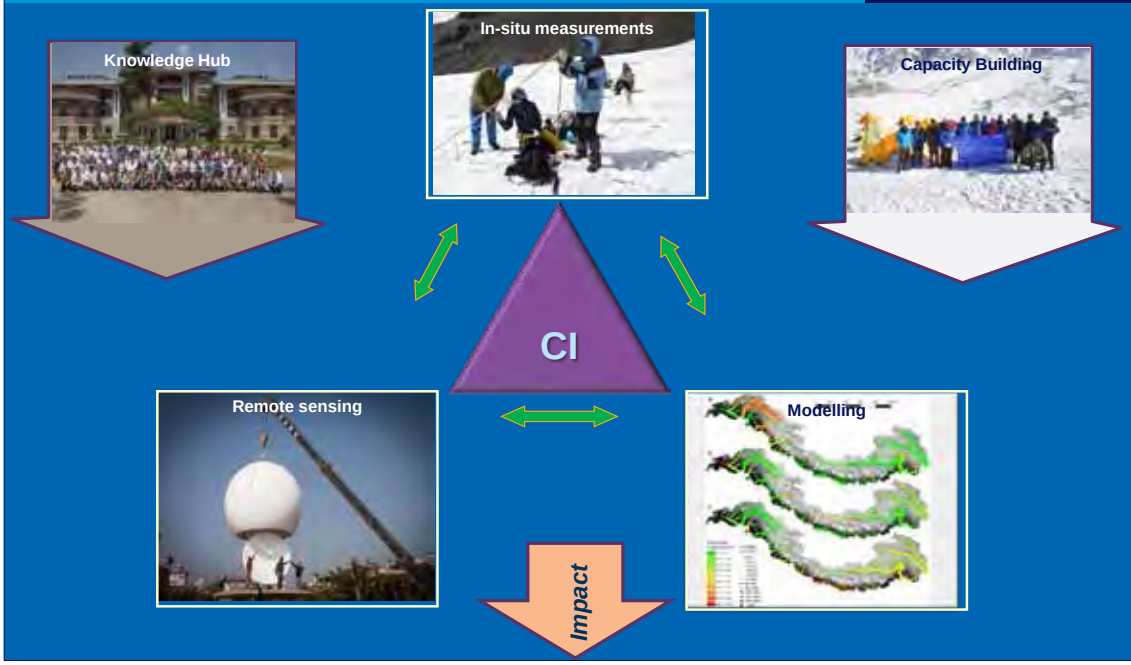

## Field Based Monitoring Complemented by Satellite Data

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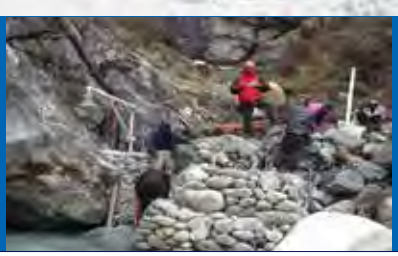

## Atmosphere Programme –
Black Carbon Mitigation Multiple Benefits

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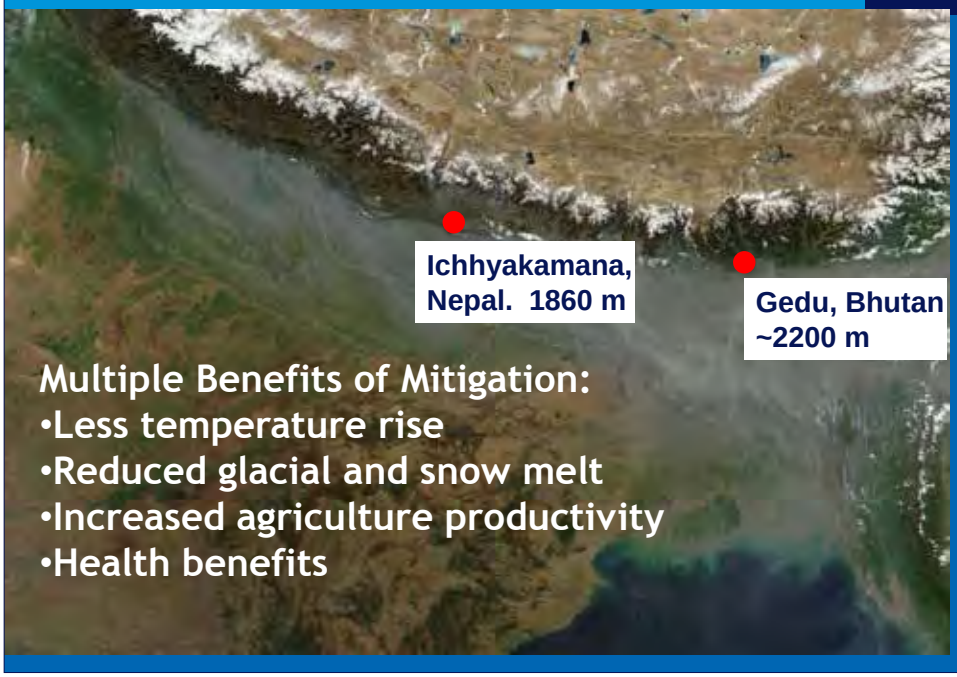


Nov to April Skies

## Mountain Environment Regional Information Systems Programme
### SERVIR-Himalaya; Regional Database

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+

Ground-based measurements

- Field monitoring
- Mobile devices
- UAVs
- Crowd sourcing
- …


Information Services for the benefit of mountain communities

HUC HIMALAYAN UNIVERSITY CONSORTIUM — Knowledge Partnership for Sustainable Mountain Development

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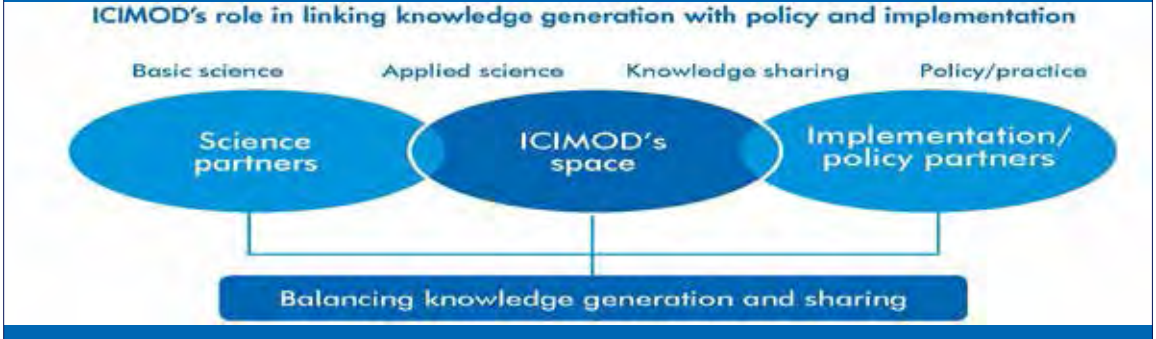
- ICIMOD serves as a regional knowledge hub
- ICIMOD's role is that of a facilitator hosting the secretariat to provide a collaborative platform
- ICIMOD Godavari Knowledge Park as support to ongoing research



## HUC on the map

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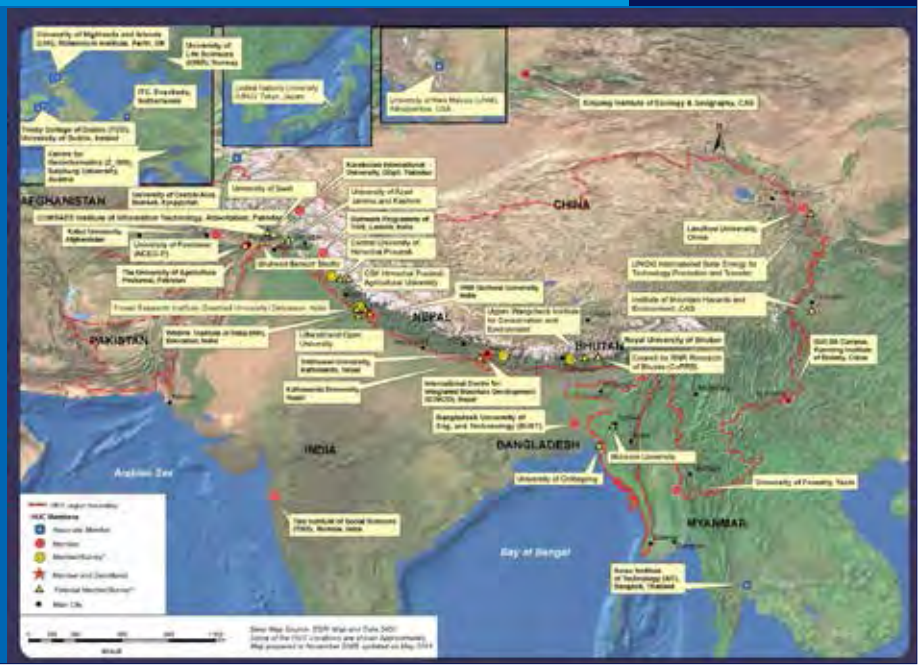
16 Full members (HKH); 8 Associate members (beyond HKH); 15+ potential members




## Measuring Success

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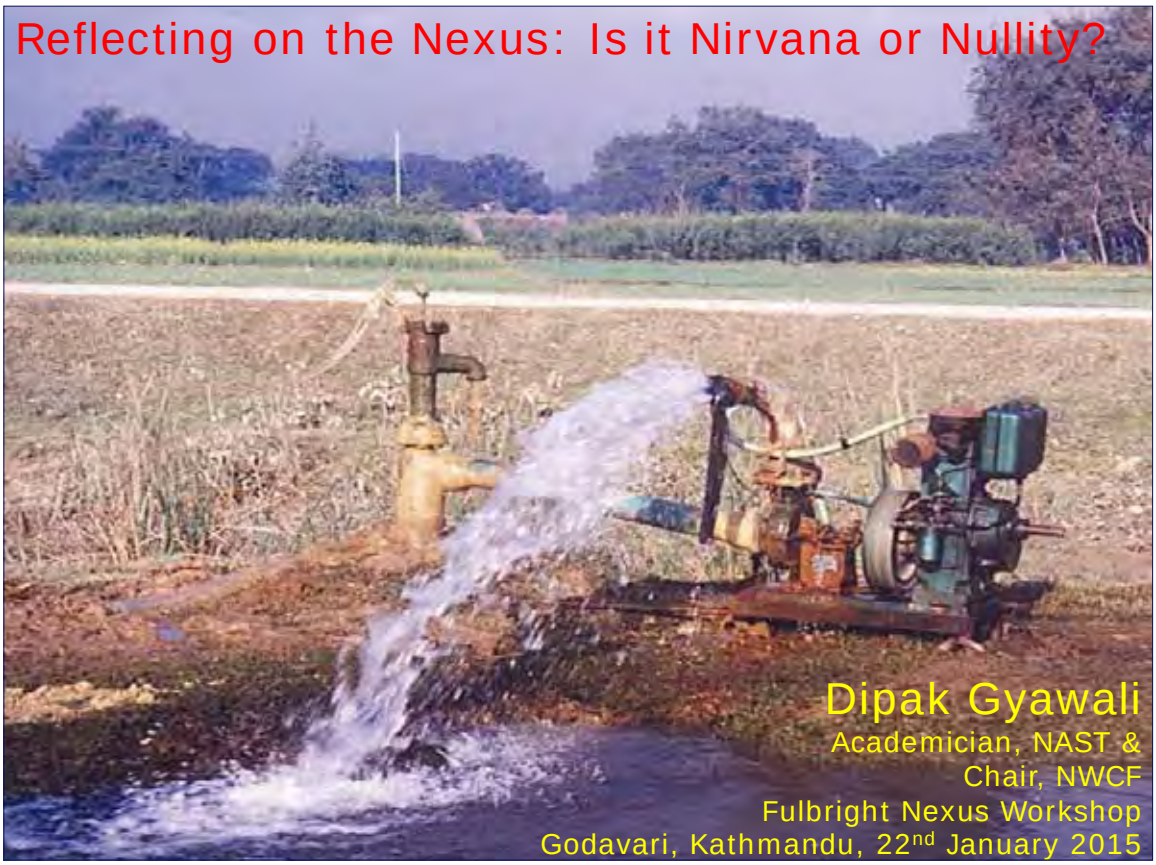
1. Widespread adoption of innovations
2. Generation and use of relevant data, knowledge, and analysis
3. Human and institutional capacity developed
4. Policies and practices influenced
5. Enhanced regional cooperation
6. Global recognition of the importance of mountains

# Thank you

ICIMOD

# Annex X: **Day III Presentation by Mr. Dipak Gyawali**




Talk Based On Following Two Pieces of Research Work

UK-based IDS Sussex's ESRC-funded STEPS Centre's *Dams, Securitisation, Risks and the Global Water-Energy Nexus under Climate Change Scenarios (KN/11015) project*, working paper by Jeremy Allouche, Carl Middleton and Dipak Gyawali. The working paper can be downloaded from: http://steps-centre.org/wp-content/uploads/Water-and-the-Nexus.pdf

The Special Issue of the on-line journal Water Alternatives www.water-alternatives.org on WEF guest-edited by the authors of the above STEPS working paper as well as their editorial introduction entitled *Technical Veil, Hidden Politics: Interrogating the Power Linkages behind the Nexus* can be downloaded from:
http://www.water-alternatives.org/index.php/current-issue

## World in Crisis and the Nexus

Two major crisis

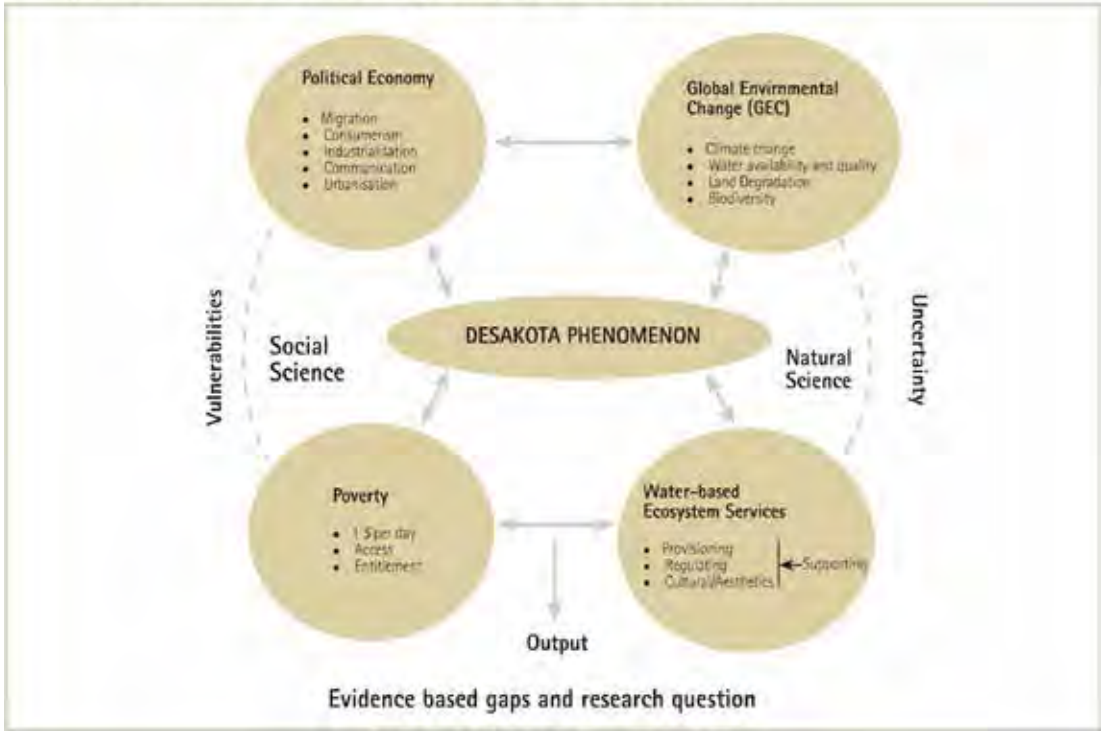
- ➢2007-8: financial crisis, global food commodity price crisis and food riots
- ➢Global energy crisis: oil prices dramatically increasing, 1st demand led crisis?

Perception of scarcity

- ➢Relationship between food, energy, water and climate change: increasing demand while supply challenges remain chronic
- ➢Concerns about long term availability of oil, gas and uranium
- ➢Climate change environmental degradation narratives, 'Critical Thresholds and Tipping Points', Planetary Boundaries.
- ➢Defining a safe operating space for humanity

Scarcity, Sustainability and Security Concerns – and the Nexus

Conceptual Framework of Interlinkages in the Desakota Phenomenon

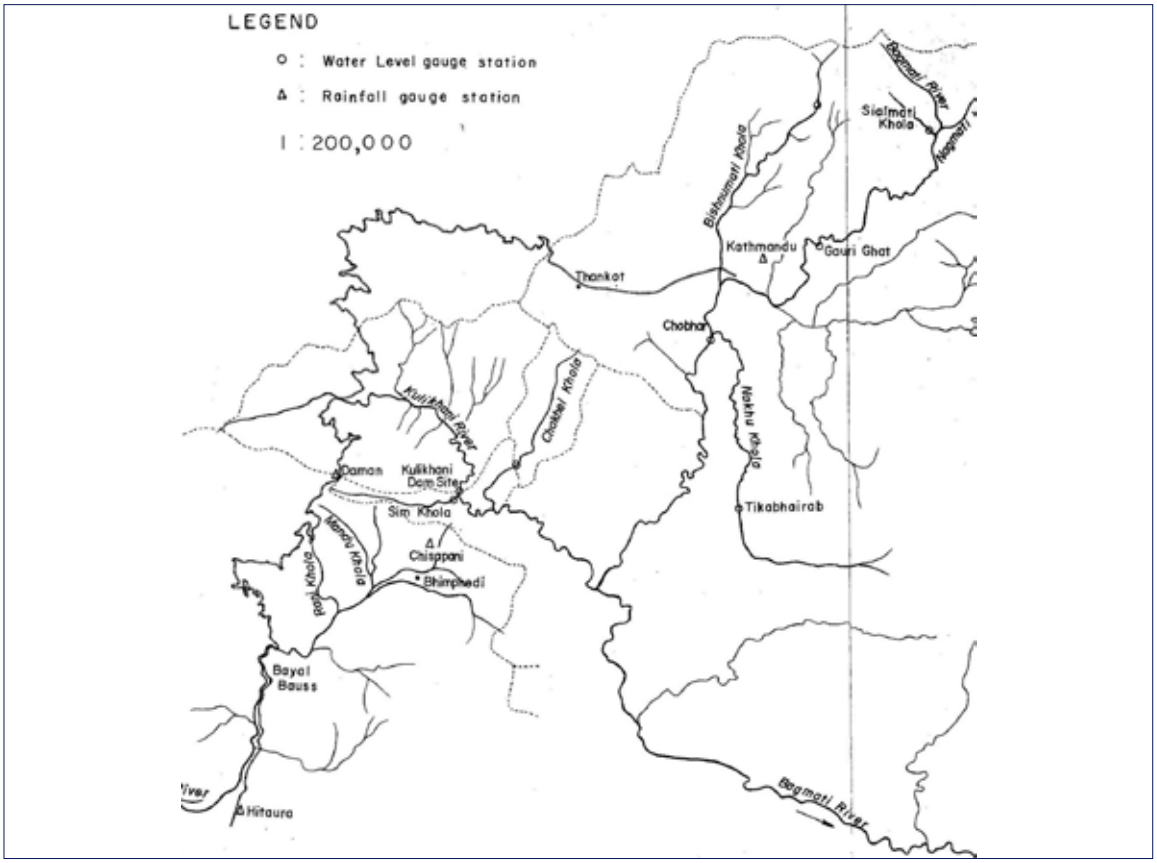



Kulekhani Reservoir's Nexused Output:

Water – Gross 85 MCM, Live 73/65 MCM

Energy – 60 MW 211 GWh

Food – 50 tons of fish



# Mass Wasting Bed Load, Palung 1993

Cloudburst of July 1993 brought 540 mm of rain in 24 hours

9 hours of rainfall with intensities upto 60 mm/hour

**Sediment yield**

| | |
|---|---|
| Designed | 700$m^3/km^2$/year |
| After 1993 floods | 38,095 $m^3/km^2$ |
| Year after in 1994 | 83,333 $m^3/km^2$ |
| Average (1981-1994) | 12,000 $m^3/km^2$/year |

## De-nexused scenario at Kulekhani:

Upstream:

✓Government-owned parastatal Nepal Electricity Authority runs 60 MW peaking storage Plant

✓Some 307 families around the reservoir (most of whom lost their land due to submergence) run informal fish harvesting system

Downstream:

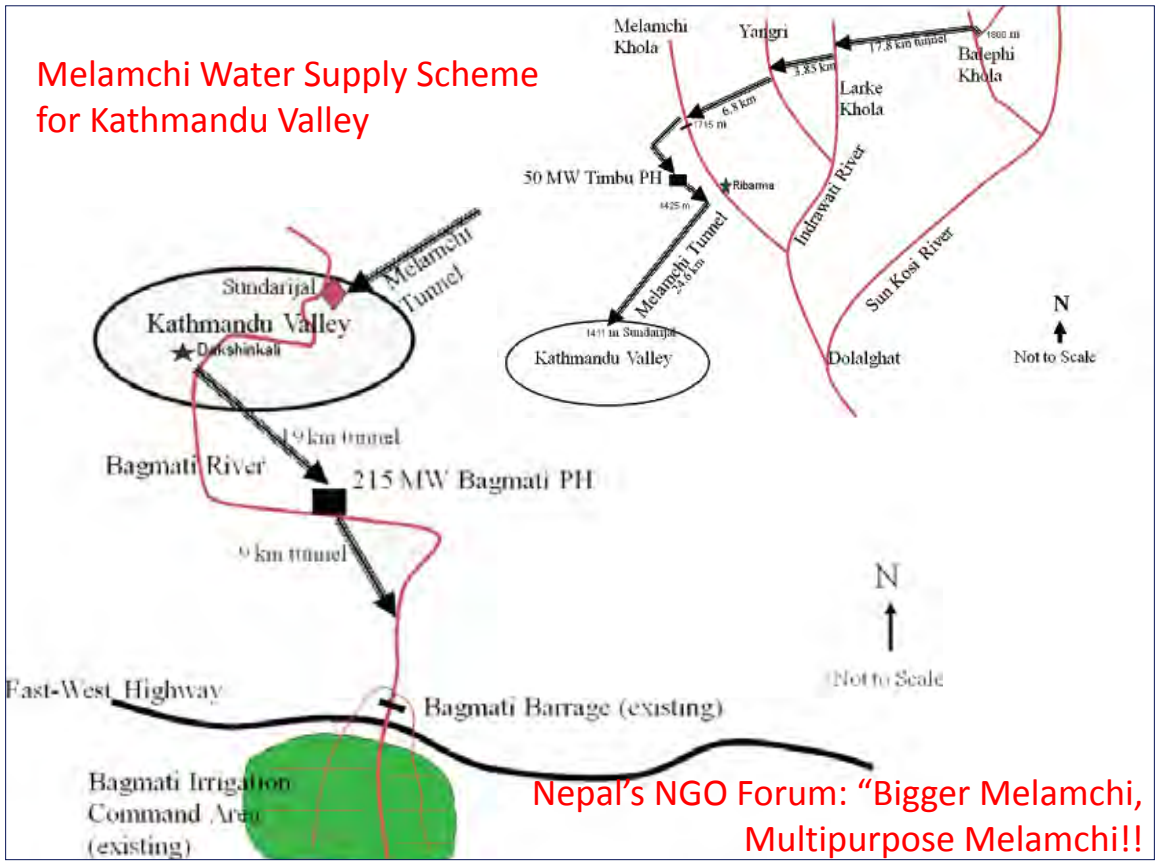
➢Government-owned parastatal Nepal Water Supply Corporation "owns" water supply and sewerage systems of Nepal's municipalities

➢About two years ago, management of Hetauda's water supply system transferred to a local board

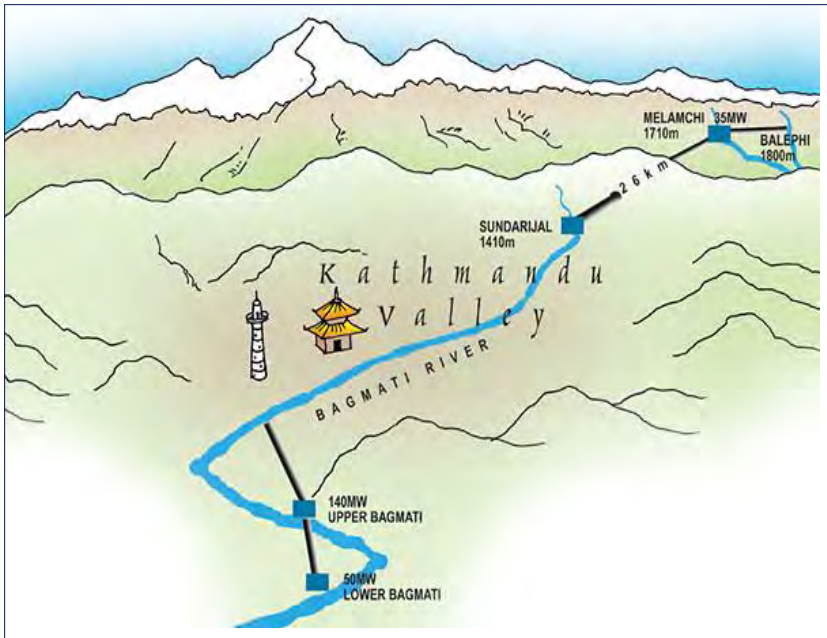
➢About a dozen Farmer-managed Irrigation Systems (FMIS) run traditional irrigation systems of 30 to 150 hectares

➢ Parsa Wildlife Forest Reserve and Chitwan National Park

Melamchi Water Supply Scheme for Kathmandu Valley




Nepal's NGO Forum: "Bigger Melamchi, Multipurpose Melamchi!!




Country gets electricity: electricity pays for the cost of the tunnel.

Kathmandu Valley gets cheaper water AND water treatment plants. Bagmati becomes clean.

But in de-nexused reality, Kathmandu gets expensive water; Bagmati remains a sewer; Tarai gets no irrigation, only Kathmandu's sewer; and the country gets no electricity!!

Tarai gets more dry season irrigation

## Nexus Approach So Far

➢A systems approach, where the interactions between different sectors are modelled as global and regional flows;

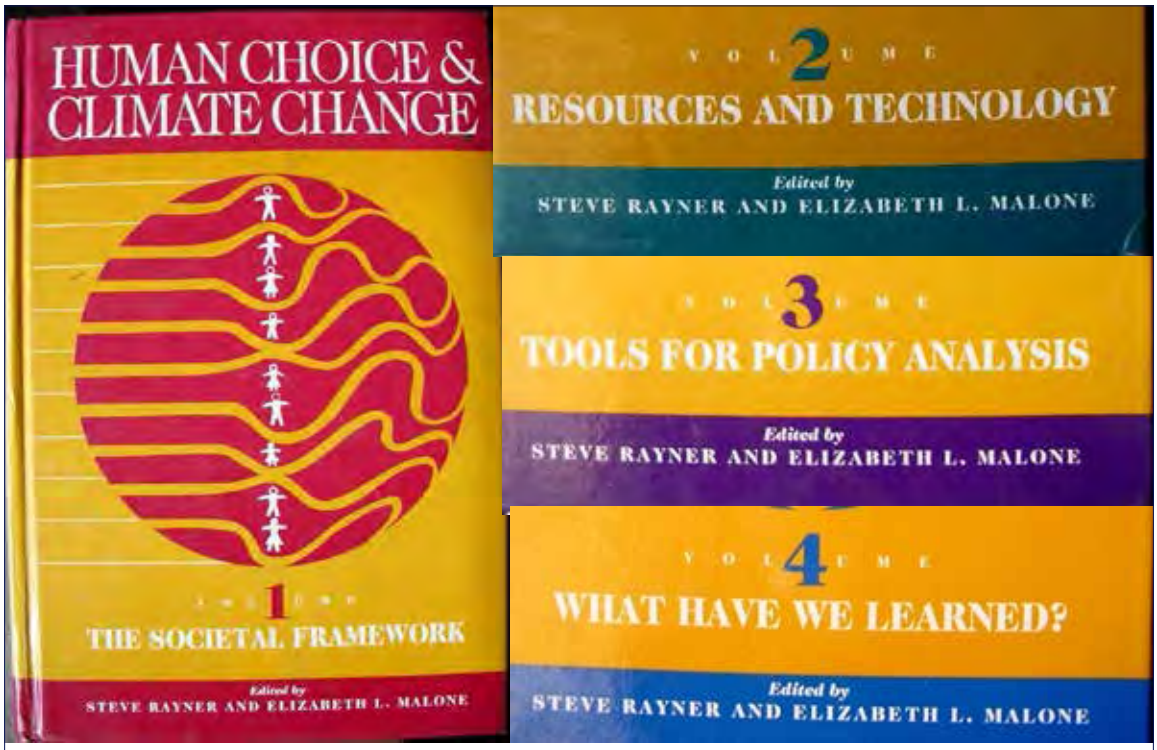
➢A decision-making tool based on these interactions, which provides an economic valuation of these resources and a market mechanism to efficiently allocate them.

## What Is Needed

✓Water-energy-food systems are complex and dynamic systems, and even more so, under the conditions of climate change.

✓To accommodate complexity and (climate) uncertainty, a shift in governance is required away from this control-orientated perspective and towards approaches where limits to control are acknowledged and incorporated (i.e. resilience and robustness solutions).

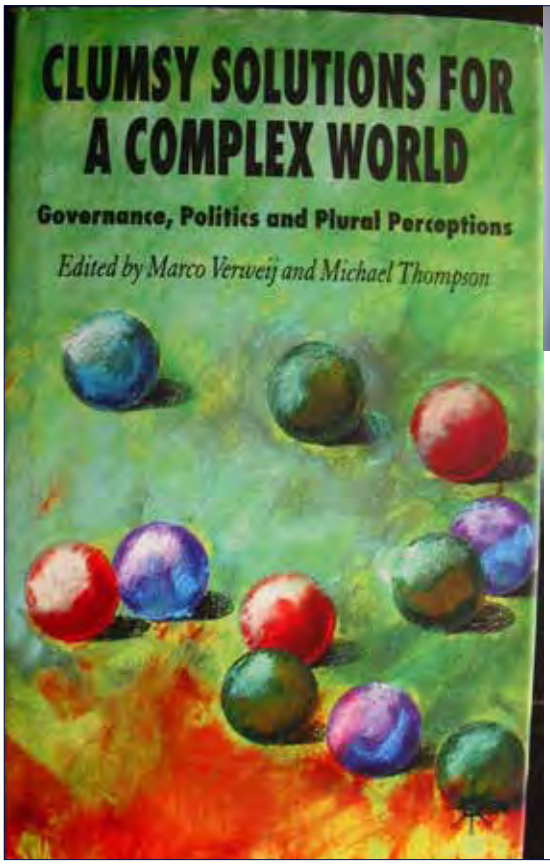
**AND WHERE DOES SOCIAL JUSTICE FIT IN ALL OF THESE DISCOURSES??!!**

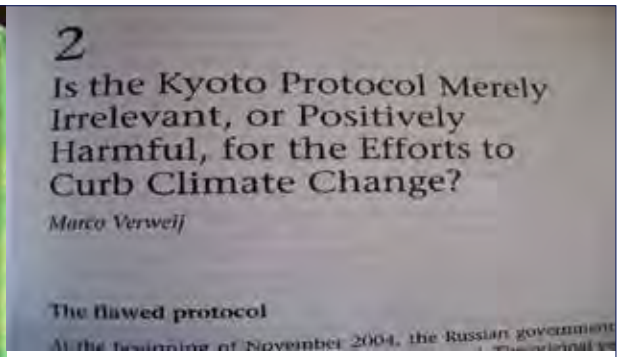



Rayner, S. and Malone, E. (eds) 1998. *Human Choice and Climate Change*. Vol 1-4. Battelle Pacific Northwest National Lab, Columbus, Ohio.

***Human Choice & Climate Change*'s Ten Suggestions for Policy Makers**

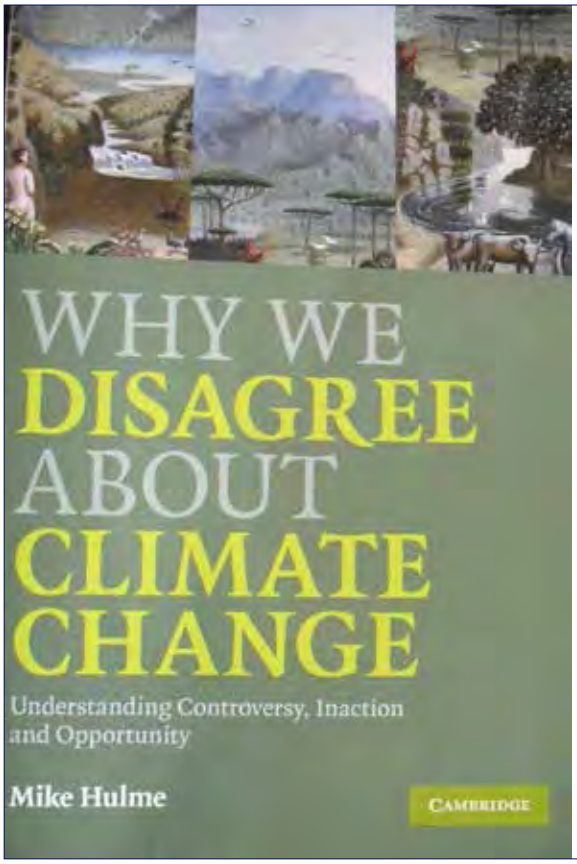
1. View climate change issue holistically and not only as emissions reduction (or adaptation: DG)
2. Recognize institutional limits being as important as environmental limits
3. Recognize likelihood that social, economic and technological change will be more rapid and have greater impact on human populations than climate change
4. Recognize limits of rational planning
5. Employ decision aids from full range of natural & social sciences and humanities
6. Design policy for real world rather than fit world into particular policy model
7. Incorporate climate change concerns into other more immediate issues such as employment, economic development, public health, security
8. Make climate policy making and implementation more regional and local
9. Direct resources into identifying vulnerability and promoting resilience in massive impact areas
10. **Use pluralistic approach to decision making**




- Cumbersome to implement international mechanisms of CDMs, JI, emission permits
- Measures insufficient to stabilize world climate even in most favourable scenario
- Trading scheme too expensive (transaction and political costs); encourages 'wait-and-see' instead of 'no regrets'
- Informed only by hierarchic procedural fetishism, ignores egalitarian and individualistic forms of governance

Marco Verweij and Michael Thompson (eds). 2006. *Clumsy Solutions for a Complex World: Governance, Policy and Plural Perceptions*. Palgrave/Macmillan Press, Basingstoke, UK.

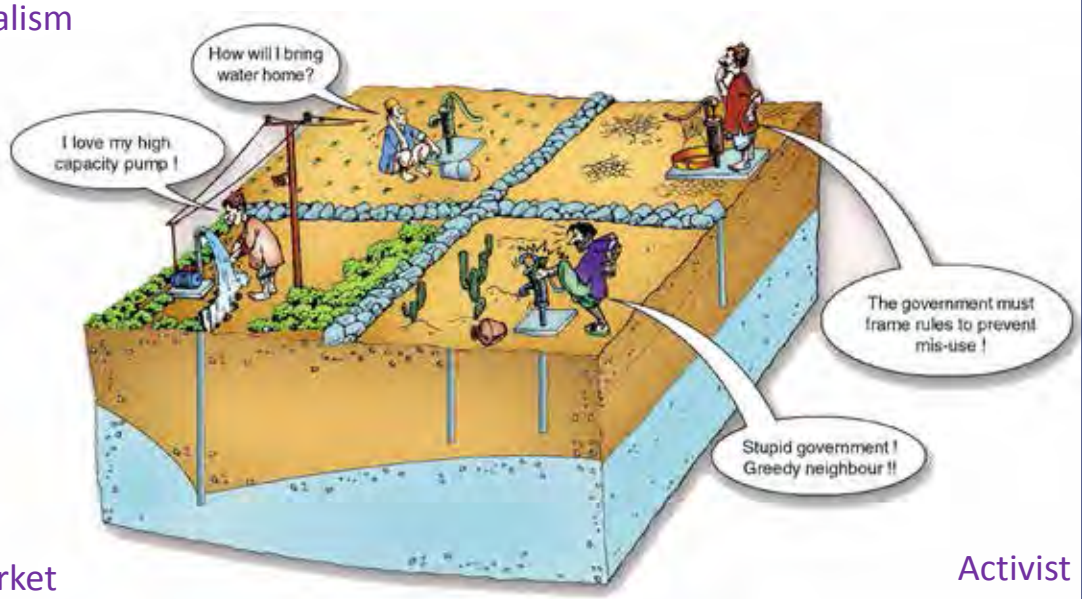



- "Climate change, global warming and greenhouse effect have different meanings popularly across languages and scientifically
- Human beings are more than material objects and climate is more than a physical entity
- Climate change cannot be 'solved' by technical and political resource mobilization like ozone depletion
- We need to understand ways in which climate change connects with foundational human attributes in psychological, spiritual and ethical work
- We disagree about climate change because we worry about different things

Hulme, M. 2009. *Why We Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity*; Cambridge University Press, UK.

Mass (Voter/Consumer) Fatalism

State Hierarchism




Market Individualism

Activist Egalitarianism

## Social Response to Groundwater Overdraft

## Constructive Engagement of Plural Social Solidarities


Agency Choice: Cement Dam, Modern cement technology

Market Choice: Diesel Pump, Donkey Cart-Mobile Phone, Irrigated Truck

Community Choice: Brushwood Dam, simple labor saving devices

Source: D. Gyawali 2003.
*Rivers, Technology and Society*, Zed Books, London

- Hierarchism: Coercive Power (*Tamasik*), Strategy of Codes and Procedures
- Individualism: Persuasive Power (*Rajasik*), Strategy of Networking Freedom
- Egalitarianism: Moral Power (*Satwik*), Strategy of Critique

## Plural Definition of the Wicked Problems
## (and the origins of innovation)

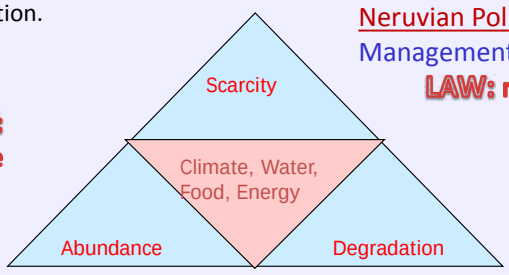
Control - too many people is the problem: Solution is to manage it through rules and regulation.

Bureaucratic Hierarchism

Neruvian Politics: Regulatory and Management Innovations

**LAW: redistributive balance**

**LIBERAL ECONOMICS: efficiency of exchange**




Market Individualism

Egalitarianism of Social Movements/Greens

Free innovation is the solution to scarcity brought about by too much control and scare mongering.

**CRITICAL ANTHROPOLOGY: reciprocal equity**

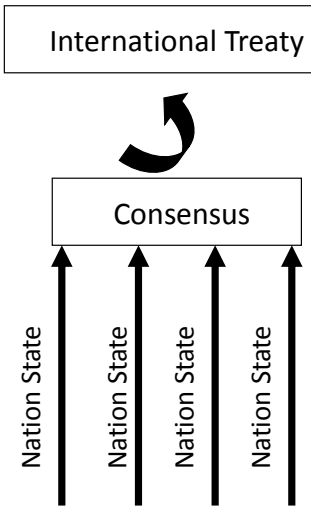
Profligacy is the problem: solution is to reign in our greed.

Regano-Thatcherite Politics: Technical creativity and innovations

Gandhian Politics: Ethical Behavioral innovations

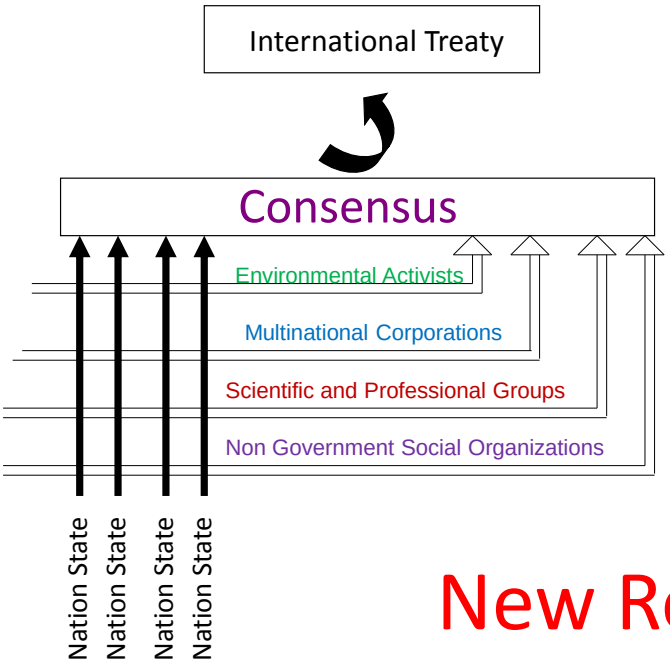
Answer is: "Many 10% Solutions"!!

*Adapted from Rayner and Malone (1998)*




## Old Assumption

Based on S. Rayner and E. Malone 1998: *Social Science Insights in Climate Change*, in Human Choice and Climate Change, Pacific Northwest National Lab, Battelle Press, Ohio.




## New Reality

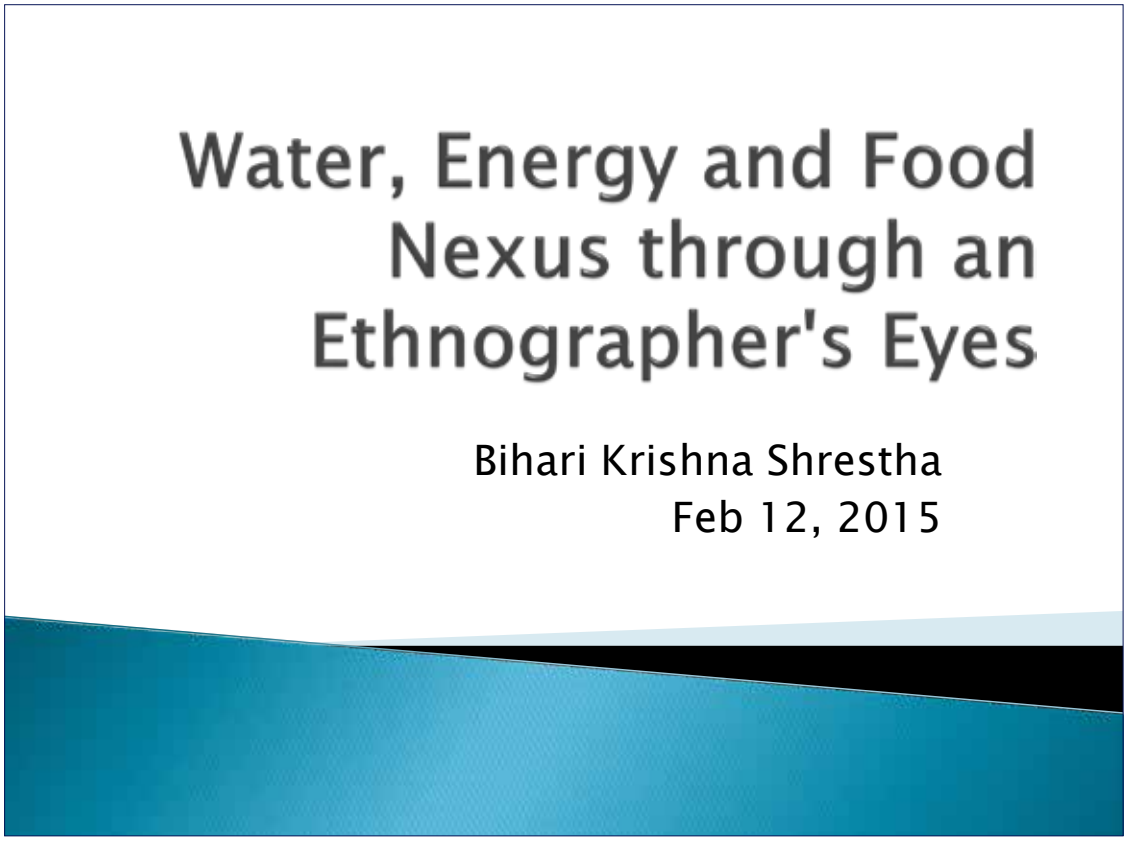
Based on S. Rayner and E. Malone 1998: *Social Science Insights in Climate Change*, in Human Choice and Climate Change, Pacific Northwest National Lab, Battelle Press, Ohio.

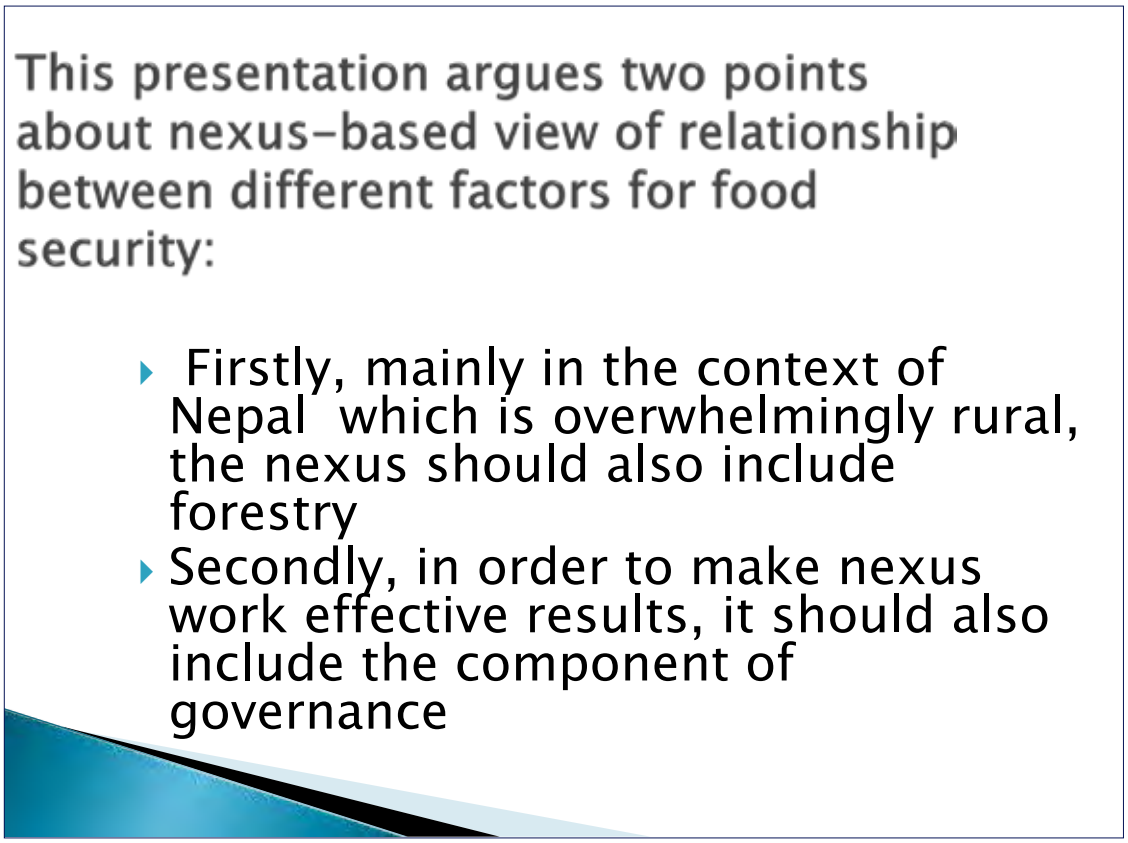
**Storage (of water but food and energy as well)as the Nexus solution**

**1. Large dams**: Collecting water where it concentrates / favoured by large water ministries (expertise, control, …); well known conflicts emerge [Hierarchs and Markets]
**2. Rainwater harvesting**: Collecting water where it falls / favoured by social activists egalitarian groups / equitable accessible, spread out wide / but not as efficient (limited in use / no energy angle, although less energy needed for pumping) [Egalitarians and Enlightened Hierarchs]
**3. Groundwater storage**: requires more energy for pumping (except mountain area from a spring) / widely available / depends on groundwater quality [Markets and Egalitarians]
**4. Storage though wetlands / soil moisture**: most environmentally friendly solution / benefits of cleaning water pollution [Egalitarians]

*Storage 'systems'* [i.e. a mix of storage types] *that combine and build on complementarities of different storage types are likely to be more effective. THE MANY 10% SOLUTIONS*

## Annex XI: **Day III Presentation by Mr. Bihari Krishna Shrestha**



## Scenario one: The case of a Jumla village, the highest rice growing village in the world

Since period of warm temperature is limited, the seed germination time is short-circuited by human intervention: prolonged soaking of paddy seed in a river and later accelerating its germination in a heated kitchen floor before broadcasting them in the carefully manicured seedbeds.

A very efficient traditional irrigation system provides irrigation water


## Scenario one: The case of a Jumla village, the highest rice growing village in the world

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A very efficient traditional irrigation system provides irrigation water

## Implications for an effective Nexus approach

- Food-focused nexus must include the forestry component too.
- Nexus— meaning arranging the relationship between various components, water, energy, and forestry to ensure optimal and tangible benefits to the community —can be effectively managed only under a decentralized system that empowers users with inalienable and decisive power.
- Vertically socially and economically stratified communities; only user managed organization could ensure equitable access to resources

*Given the stubborn persistence of feudalistic socio-economic order*

—ascriptive leadership based on the convergence of high caste and class that thrive on extraction of resources from the state, community and environment without accountability

—political and bureaucratic leadership remain necessarily corrupt. Therefore, Nexus components would only "grow" only in isolation.

They do not mix in a "Nexus".

**Role of the aiding agencies:**

- Negotiate on behalf of the potential and effective "Nexus" ;
- Focus on empowering the communities

Building "Nexuses" at supra-community levels only as an outgrowth of the effective nexus-relationship at the community level.

That is, building nexus around the concept of accountability to the communities.

## Annex XII: **Day III Presentation by Dr Dwarika Nath Dhungel**

# Water, Energy and Food Nexus through Institutional Lens: A Case of Nepal

Dwarika N. Dhungel
Feb 12, 2015

## Institutional Arrangement ( Local Level )

- Local Governance Bodies
  - Village Development Committee /Municipality
  - District Development Committee
- Local and District level offices of the line agencies, such as the district agriculture office etc.

## Cont…

- **Local Governance Bodies** are supposed to coordinate the planning and programming related to the water, food and energy
- At the district level, provision for the **Integrated Plan Formulation Committee** with the **District Chairperson as the chairperson and the representatives of the district level sectoral agencies as the members**

## Cont…

- But due to the non election to the local governance bodies for a long time ( since 2002):
  - the planning process at the local level is primarily sectoral in nature with no coordination among the concerned local level offices of the different agencies

# National Level

- National Planning Commission – National Planning Body
- Water and Energy Commission (WEC), established in 1975 with a secretariat headed by a permanent secretary level officer

# WEC Composition

- Chairperson – Minister of Energy
- Member:

  Member, National Planning Commission

  Secretaries of the 11 Ministries

  Two nominees of the Govt. ( With two years term)

## Cont…

Dean, Institute of Engineering, Tribhuvan University

President, Nepal Engineers' Association

Representative, Federation of Nepalese Chamber of Commerce and industry

Member Secretary
Secretary, WEC Secretariat

## WEC-Establishment Objectives

- To provide assistance to the concerned ministries in formulation policies and objectives to be included in the perspective/periodic plan relating to the water resources and energy sector.

## Cont…

- To provide suggestion, recommendations and guidance with regard to:
  - the multipurpose (mega and medium scale only) projects' development as well as to irrigation, hydropower, drinking water, industrial use of water, flood management and water navigation;
  - the promotion and development of mega and medium scale projects, and protection of environment aspects relating to the use of water

## Cont…

- Formulate policies and strategies for the water resources and energy sector
- Render opinion, advice and recommendation on the bilateral and multilateral issue relating to water resources and energy

## Issues

- Food does not come under the purview of the WEC from the perspective of providing input to the Government
- After abolition of the Ministry of Water Resources on Political Consideration and two ministries were created:
  - Ministry of Energy
  - Ministry of Irrigation

## Cont…

- WEC has nothing to do with the resource allocation and program finalization in relation water related sectors
- National Planning Commission and the Finance Ministry are responsible agencies for resource allocation and program planning
- Sectoral approach has remained the planning strategy in the water related sectors

## Cont…

- As a Consequence :
  - Ministry of Irrigation for all practical purpose has forgotten the WEC
  - Ministry of Irrigation takes the decision on the placement and transfer of irrigation related professional to and from the WEC, where there is a provision for the posting from this ministry

## Cont…

- WEC :
  - is only a recommendatory body, whose decisions are more forgotten than pursued.
  - has no monitoring responsibility on the use of the water resource in the different sectors
- No regularity in its meeting, since more than one year there has not been meeting of the WEC

## Ways Forward – Few Suggestions

- Re establishment of the Ministry of Water
- Review of the WEC from the point perspective of the water, food and energy nexus perspective
- Role of the National Planning Commission and the WEC in relation to the water-food – energy sectors needed to be revisited and their relationship be clarified

## Ways Forward – Few Suggestions

- Strengthening of the WEC Secretariat
- Provision for the Water, Energy and Food Committee at the local bodies
- Orientation to Politicians and Parliamentarians on the importance of the Water-Energy and Food Nexus

Thank You

## Annex XIII: **Remarks by US Deputy Assistant Secretary of State, *Ms Fatema Z Sumar***

### Introduction

Thank you for the kind introduction. I want to thank Dr Vasily of the Nepal Fulbright Commission for bringing us all together to discuss the water, energy, and food nexus. I also want to recognize the efforts of our partners, Dr Molden and the International Centre for Integrated Mountain Development, Dr Young of the World Bank, and Dipak Gyawali of the Nepal Water Conservation Foundation. I understand Mr Gyawali is himself a Fulbright alumnus. I am pleased to be joining all of you today, along with our water, energy, and food experts, and all of our outstanding Fulbright alumni.

The Fulbright programme is one of our most respected programmes and is an excellent tool for building stronger ties with the region and within the region. Over 360,000 Fulbrighters have participated in the programme since its inception almost 70 years ago in 1946. I am proud to report that for the 2014–2015 academic year there are nearly 1,000 Fulbright participants from South and Central Asia or completing their fellowships in the region.

South and Central Asia is home to some of the most pressing challenges and biggest opportunities in the 21st century. Programmes like Fulbright are incredibly important in this neighbourhood. We are proud to support both your cutting-edge scholarship and your important work enhancing people-to-people ties that serve as the foundation for international cooperation.

### Recognizing Fulbright work in the region

In focusing on water, energy, and food issues, you and your colleagues are creating enduring benefits for a region that will depend on research and innovation to create stability and prosperity. Already, your work is changing lives.

For example, Fulbright alumni designed the SONO filter to treat and remove arsenic from well water and developed the Drinkwell Project for community-based safe water systems in rural areas.

Alumni have also conserved India's vanishing rice varieties, conducted research on the first approved genetically modified food in South Asia, and aided marginalized women working as street food vendors in Kolkata to prepare safe hygienic food that adheres to environmentally conscious business practices. And, given growing concerns over climate change, research by another alumnus focused on the Brahmaputra River in India helps us focus on how climate change affects the region.

### The water-energy-food nexus

Even with these inspiring accomplishments, we recognize that too often water, energy, and food are addressed as separate issues. The Nexus effort – both globally and in this workshop in Kathmandu – is a strategy meant to shape a traditionally disparate approach to water, energy and food and highlight their interconnections. We all know that innovation in the water sector can dramatically affect how people access and use energy and food. A dynamic energy sector can streamline production of food and the accessibility of water. A more efficient, sustainable food sector impacts and shapes water and energy usage.

If we focus on water, there are predictions that by 2025, as much as two-thirds of the world's population could be living under water stressed conditions – where water has become an impediment to socioeconomic development. Agriculture is the largest global consumer of freshwater, and irrigated agriculture provides 40% of the world's food. Increasing food production to alleviate hunger and meet the demands of a growing world population means ensuring that sufficient water is available when crops need it. It also means that improving agricultural water management is essential. When we consider the United Nations' Post-2015 Development Agenda, we see the critical link between energy, economic growth, and poverty eradication, as well as a range of other thematic issues such as food, water, climate, and health.

## Our approach

With such issues confronting us, the United States recognizes the need to increase international water security. We need to ensure that everyone has the water they need, where they need it, when they need it – in a reliable and sustainable manner. To achieve this goal, the United States is working on five lines of effort to: 1) improve hygiene and increase access to safe drinking water and sanitation; 2) improve water resources management; 3) increase the productivity of water; 4) improve water treatment and recycling; and 5) mitigate tensions associated with shared waters. We are doing this through five specific approaches: 1) capacity building, institutional strengthening and policy/regulatory reform; 2) diplomatic engagement; 3) direct investments to meet immediate needs, build infrastructure, and mobilize local capital; 4) investment in science and technology; and 5) new partnerships to develop solutions.

To address the water challenge, we must build political will, strengthen capacity, mobilize resources, advance science and technology, and develop partnerships that can deliver meaningful results on the ground. Perhaps the greatest challenge is mustering the required political will to create lasting change. While this is a global challenge, the solutions are local. Communities and governments must work towards meeting the basic needs of their people. This means prioritizing water issues in national development plans and strategies and providing budget support to meet these goals.

## Water and food security

Based on current water use, food consumption trends, and predicted population growth, by 2050 agricultural production will need to increase by 70% to support the food chain. To attain food security, we need to use water and energy more efficiently and lessen agriculture's negative effects on the water supply. Better water resources management, sustainable and equitable access to water and use of improved, energy-efficient technologies are steps in this direction. We also need to protect water resources and wetland systems that support fisheries, which provide a significant source of protein to two and a half billion people in developing countries.

## Water and energy

The energy-water nexus is an important issue for the United States domestically and internationally, as we, and others, strive to strike a balance between energy supply and the sustainable development of our natural resources. In South Asia, nearly 500 million people lack access to reliable energy and, in recent years, in Nepal alone consumers have experienced up to 18 hours a day of blackouts during the dry season. By 2050, there will be 9 billion people on Earth requiring more energy, more water, and more food than today. This is a global challenge, but there are solutions. Working together, we can overcome these challenges using innovative technologies and policies. What steps can we take to move forward?

Get data. We need to better understand the problem, the connections, and the impacts by generating, using, and openly sharing improved sources of data.

Deploy technology. Let us implement innovative, off-the-shelf technologies that promote energy and water efficiency, use non-traditional sources of water for energy production, and generate or create water and energy from waste.

Work together. Energy and water decision-makers must work together to ensure that decisions made by one sector do not impact on the other. We can help by strengthening institutions and establishing mechanisms for joint planning and development across sectors.

Use incentives. Incentives are an effective tool to encourage the conservation of water and energy. We can start working to create policy and regulatory frameworks that strengthen local capacity and enable businesses to serve as a catalyst for change.

Internationally, the State Department is supporting nexus dialogues – including this one in Kathmandu – to share best practices that can help countries address their energy and water challenges. The United States is committed to finding and implementing solutions to these problems and welcomes the opportunity to partner with other governments and civil society in this effort.

## Hydropower

Hydropower is a bright spot in the energy story. Last December, the US Millennium Challenge Corporation expanded Nepal's threshold programme to a full compact agreement, bringing with it additional resources to develop key industries like energy that support economic growth. With 40,000 megawatts of commercially viable potential, and with the right steps, Nepal could be a source of emission-free power for itself and South Asia. A recently signed Power Trade Agreement between India and Nepal provides a framework for market-based power exchanges. In addition, the Investment Board Nepal completed Power Trade Agreements with Indian consortiums on two 900-MW projects, the Upper Karnali and Arun III plants. Now is the time to seize the momentum and help Nepal fully realize its hydro potential, which will unleash economic prosperity for its citizens and the entire region.

As we consider the best strategies to support Nepal's hydropower development, we must take measured decisions with affected stakeholders that rely on the best available science. This includes a focus up front on water basin management and environmental and social impact. Nepal has a real opportunity here to undertake long-term strategic planning to develop its hydro potential in a way that is economically and environmentally sustainable.

## Water and climate change

I want to turn for a moment to another key area – climate change. The Intergovernmental Panel on Climate Change, the US Climate Action Report, and other reports say the same thing. Climate change affects every aspect of food security, from production to pricing.

Climate change is not some distant threat. Globally, the 14 warmest years on record have all been since 1998. Droughts and wildfires have become more frequent and more intense in some regions, while flooding has intensified in others. Deserts are expanding. Water quality and quantity are being affected by changes in precipitation and runoff. Sea level rise is now increasing at about twice the average rate it was in the 20th century.

These are the facts – and the United States is taking action to combat climate change by reducing carbon emissions and increasing our use of renewable and clean energy resources at home, and helping other countries do the same around the globe. As you are all aware, in recent months President Obama has announced new cooperation with China and India on climate change and renewable energy. And the United States is working with governments throughout South Asia on green energy, clean cook stoves, and disaster risk resilience.

## Conclusion

As I conclude, let me stress that the United States and the countries of South Asia are working hand-in-hand to pursue development in a way that boosts local economies and sustains the environment. This requires good data for proper analysis and planning, smart investments, strong leaders, and effective institutions to manage environmental resources for the benefit of the region.

You, as the Fulbright, Humphrey, and International Visitor Leadership Program Alumni and other experts pioneering our approach to the nexus, represent the future. We appreciate your work and look forward to learning more about your accomplishments in the months and years ahead.

Thank you, and I look forward to hearing your views.

# Annex XIV: **Workshop Evaluation Report**

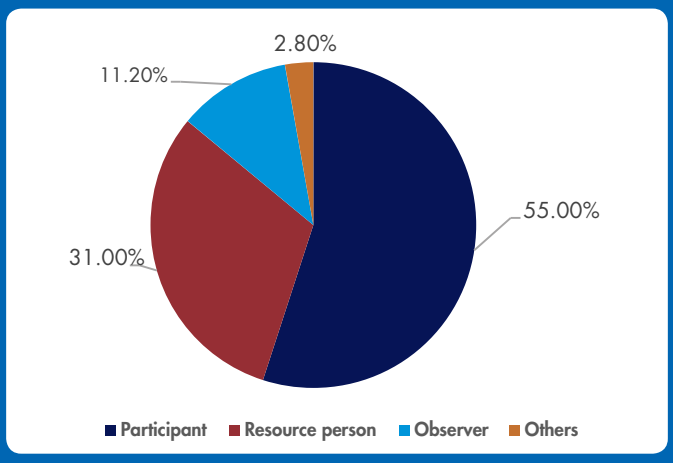
## Evaluation based on feedback:

Feedback on the Fulbright Water-Energy-Food Nexus Regional Workshop was evaluated based on the evaluation survey as submitted by the workshop participants.

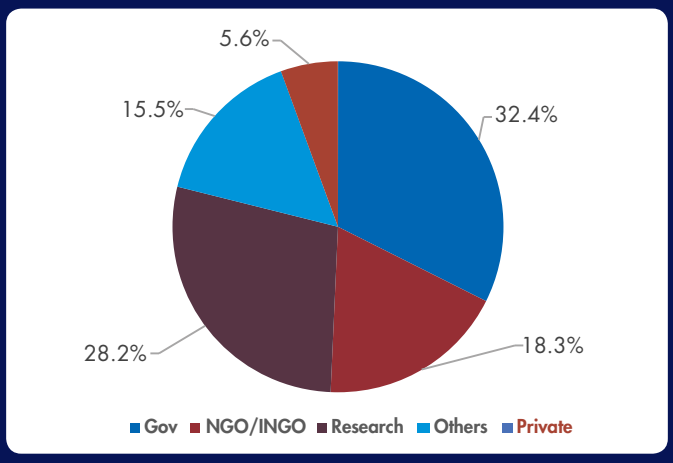
Workshop participants made up the majority of respondents, although members of the organizing team including observers and resource persons also responded to the evaluation. In terms of working sector, the respondents to the evaluation survey were largely from the government sector (33%).

Interestingly, the majority of the respondents recommended the participation of government officials and politicians in forthcoming workshops to enhance the effectiveness of such workshops, while 33% of the participants indicated they are working in the government sector.

### Role of respondent in the workshop

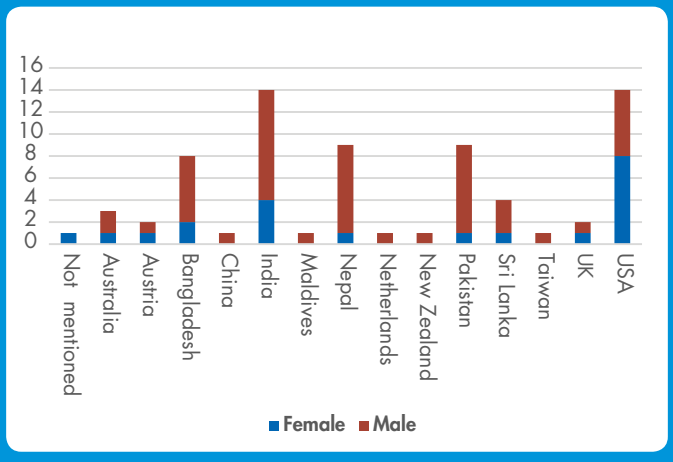



### Working sector of the respondents




Participants from 14 countries were represented at the workshop, with participants from India and the United States the highest in number.

### Country of origin and gender of respondents




| Country | Female | Male | Total | % |
|---|---|---|---|---|
| Not mentioned | 1 | - | 1 | 1.41 |
| Australia | 1 | 2 | 3 | 4.23 |
| Austria | 1 | 1 | 2 | 2.82 |
| Bangladesh | 2 | 6 | 8 | 11.27 |
| China | - | 1 | 1 | 1.41 |
| India | 4 | 10 | 14 | 19.72 |
| Maldives | - | 1 | 1 | 1.41 |
| Nepal | 1 | 8 | 9 | 12.68 |
| Netherlands | - | 1 | 1 | 1.41 |
| New Zealand | - | 1 | 1 | 1.41 |
| Pakistan | 1 | 8 | 9 | 12.68 |
| Sri Lanka | 1 | 3 | 4 | 5.63 |
| Taiwan | - | 1 | 1 | 1.41 |
| UK | 1 | 1 | 2 | 2.82 |
| USA | 8 | 6 | 14 | 19.72 |
| Total | 21 | 50 | 71 | 100 |

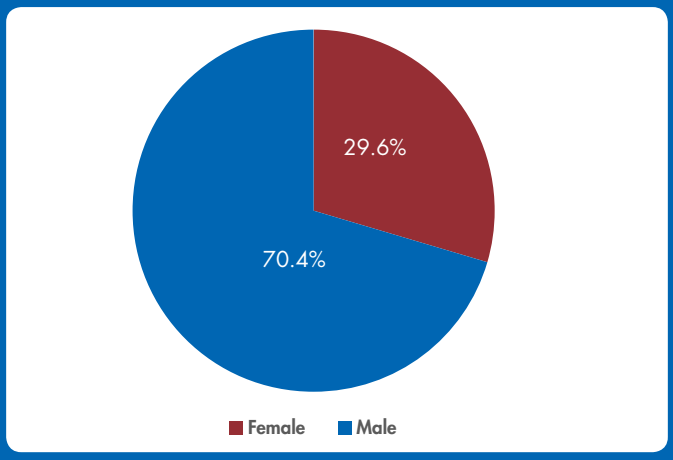
The overall gender balance in the workshop was 30/70 (female/male), with a relatively greater number of female participants from the United States. The gender ratio among South Asian participants was 20/80 female/male.

Approximately 40% of the respondents considered the workshop to be excellent and 32% rated it very good. Regarding the effectiveness of the event, 38% of the respondents said that the ideas and learning from the workshop will help them to perform their job responsibilities better and 35% felt that the workshop would help them to better understand the subject matter and related issues.

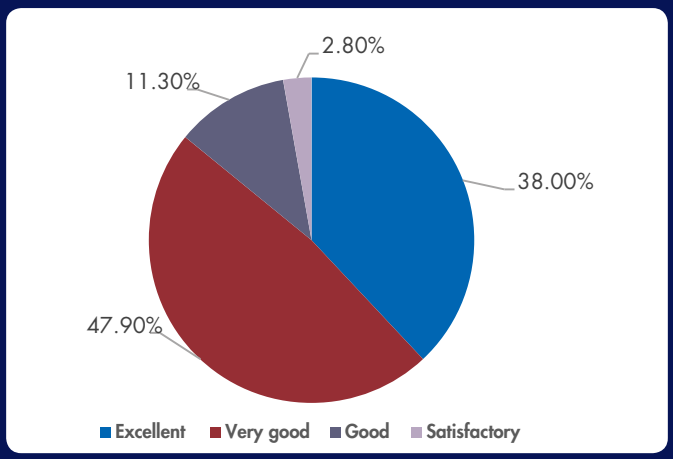
The majority of respondents appreciated the resource persons of the workshop and rated them as very good or excellent.

A large number of respondents mentioned the presentations of Professor Christopher Scott, Mr Dipak Gyawali, Dr Aditi Mukherji, and Dr Bill Young and said that they found them useful and appreciated looking at the WEF nexus through the social and institutional lens. Participants in the workshop who were alumni of US Government exchange programmes noted that regional alumni programmes such as this workshop helped them to broaden their knowledge and to network, thereby influencing their work positively.

**Overall gender ratio in the workshop**




**Overall rating of the event**




The majority of respondents appreciated the excellent facilitation during the workshop, although noting that more time could have been allocated for discussion. In addition, some of respondents said that the workshop was very useful in helping them to understand WEF issues on the regional level and to come up with innovative ideas and recommendations. At the same time, some respondents mentioned that more time was needed to discuss the WEF nexus, which comprises a very large and complex set of issues. Summing up the feeling among participants, one of the respondents said that the workshop was "A very good beginning to talk about the WEF Nexus in the region".

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