

## Food, Water, Energy Nexus in arena of Climate Change

### Publication History

Received: 11 November 2016

Accepted: 30 December 2016

Published: January-March 2017

### Citation

Kirit Shelat. Food, Water, Energy Nexus in arena of Climate Change. *Climate Change*, 2017, 3(9), 132-145

### Publication License



© The Author(s) 2017. Open Access. This article is licensed under a [Creative Commons Attribution License 4.0 \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).

### General Note

 Article is recommended to print as color version in recycled paper. *Save Plants, Save Climate.*

## **Food, Water, Energy Nexus in arena of Climate Change**

Dr. Kirit Shelat, I.A.S. (Retd)  
*Executive Chairman - NCCSD*

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food to pump water from ground water or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods.

They are also the key to provide sustainable development, livelihood and for that matter for poverty reduction.

The demand for fresh water, energy and food will increase significantly over next decades under pressure of increased urbanization, growing middle income families, increased manufacturing activities, transportation, diversified diets, so on and so forth. As per FAO estimates, this situation is expected to be exacerbated in near future as 60 percent more food will be needed for the growing world population. The Global Energy Consumption is projected to grow up by 50% by 2035. Total Global water withdrawals for irrigation are projected to increase by 10 percent by 2050.

As demand grows, there is competition between different stakeholders particularly agriculture, the farmers and urbanities and within the village level for drinking purpose of families and livestock and for farming.

As a concerned citizen, we are aware of food, energy and water challenges, but and addressed them in isolation, within sectoral boundaries. At district level, fragmented sectoral responsibilities, lack of coordination and inconsistencies exists. If water, energy and food security are to be simultaneously achieved, decision makers, need to understand. A nexus approach to sectoral management, through enhanced dialogue, collaboration and coordination, is needed to ensure that co-benefits and trade-offs are considered and that appropriate safeguards are put in place particularly in the arena of climate change is a serious threat to food, water and energy security and most important challenge in this millennium.

**The Complementarities and co-benefits from nexus-based adaptation are as under**

<b><i>Key Characteristic</i></b>	<b><i>Nexus approach</i></b>	<b><i>Climate change adaptation</i></b>	<b><i>Complementarities and co-benefits from nexus-based adaptation</i></b>
<b><i>Goal</i></b>	Achieving water, energy, and food security objectives and sustaining resources through efficient use of available resources	Build resilience and enhance adaptive capacities against climate and other risks	Understanding adaptation to climate change is critical for addressing nexus challenges, and efficient use of resources is critical for effective adaptation
<b><i>Core principles</i></b>	Minimize resource waste and maximize economic efficiency, while accelerating the sustainable supply	Reduce vulnerability by managing climate risks and building response capacity	Since resource scarcity often increases people’s vulnerability, the nexus approach may contribute to facilitating adaptation and vice versa
<b><i>Main focus</i></b>	Provide integrated solutions at Implementable policy Frame work with solution at multiple stage.	Minimize shock, risks, and vulnerability and address impacts and risks associated with climate change	Understanding vulnerability to climate change is crucial for assessing nexus challenges; equally, integrated nexus solutions can contribute to reducing vulnerability and poverty
<b><i>Broad strategies</i></b>	Policy integration, Harmonization of existing schematic local level planning and implementing by involving public governance system with multi by and crust cutting stakeholders with community partnership harmonization, and governance to build synergies and generate co-benefits across sectors by	Addressing the drivers of vulnerability to climate change in specific sectors through building adaptive capacity and resilience	Addressing the drivers of vulnerability to climate change in specific sectors through building adaptive capacity and resilience

	engaging multiple stakeholders, public-private partnership		
--	--	--	--

Source: Adapted from Golam Rasul & Bikash Sharma (2015)

**Synergies between the climate change adaptation and nexus approaches**

	<i>Sector-specific adaptation measures</i>	<i>Positive implication for the Sector</i>	<i>Potential for synergies across the nexus</i>
<b>Water</b>	<p>Increasing water use efficiency E.g. Switching to drip irrigating</p> <p>Switching from use freshwater to wastewater-recycle-water-for Farm-irrigating</p> <p>Switching from wet to dry cooling at thermoelectric power plants Desalinization</p> <p>New storage and conveyance of water to serve new demands</p> <p>Watershed and river basin management</p>	<p>Reduces water use per capita</p> <p>Reduces freshwater use per capita</p> <p>Reduces water use and associated thermal pollution</p> <p>Increase in brackish and freshwater supplies</p> <p>Increased water supplies to meet demand</p> <p>Increased water supplies to meet demand</p>	<p>Increased availability of water for energy and Agriculture</p> <p>Increased availability of freshwater for food, energy, and other uses</p> <p>Increased availability of water for energy and agriculture</p> <p>Increased availability of freshwater and overall water supply for energy, agriculture, and other uses</p> <p>Increased availability of freshwater and overall water supply for energy, agriculture, and other uses</p> <p>Increased water supply for energy and other uses, improved water quality, reduction in flood potential</p>
<b>Land</b>	<p>Switching to drought-tolerant crops and promote drought resistant original and breeds develop Sea-weed as a marketable</p>	<p>Increased/maintained crop yield in drought areas</p> <p>Increase in renewable energy</p>	<p>Reduced water demand</p> <p>Reduced pressure on non-renewable energy</p>

	product.  Using waste or marginal land for grass land development to support Livestock development.		as some fossil fuels are replaced with biofuels
<b>Energy</b>	Increasing transmission capacity and reduce transmission losses Enhancing efficiency of existing renewable energy, like solar, wind, biogas, and bio energy at local level and replicating them on mass-scale.	Reduced economic and social impacts Increased clean energy and reduced pressure on energy	Potential for reduced emissions if new transmission and wind/solar power supplied to the grid Reduced GHG emissions, reduced water demand for cooling, thermal power

Source: adapted from Skaggs, Hibbard, Janetos, and Rice (2012).

### **The Indian Situation**

Indian Economy is doing extremely well. The rate of growth of GDP is between 7 to 8%. Poverty in rural areas has declined from 80% to 20% prior to Independence. Country used to import food grains in the initial years, but since then it has gained self sufficiency and now exports.

Agriculture growth has been steady at the average of 2% to 4% except last two years. Although rural livelihood has improved, there are huge numbers who are behind poverty line. The farmers like to leave farming as it is not profitable – some wed Naxalism – others migrate. Although Country has achieved Food Security and both Food Security and employment are now guaranteed to the poor people by an enactments but the sustainable livelihood is still an issue.

***The Food Security and Livelihood are inter-related and there are problems.***

**Food Security:** Due to rapid increase of non-agriculture activities like urbanization, industrialization and infrastructure development, area under agriculture and food production is getting reduced. With increasing urban middle class population, demand for food, Dairy and Meat products is increasing. There will be huge gap between demand and supply position in years to come.

**Water Scarcity:** Again due to enhanced urbanization and Industrial activity, even water meant for irrigation in Dams and Reservoirs– Lake are getting diverted to meet increased urbanities demand. Further big new Township are using huge pumps which draw out daily large quantity underground water which resource is becoming increasingly depleted.

**Energy Scarcity:** Deficient supply of Electrical energy in rural areas –There is only 30% to 40% of energy demands of rural household is met-with. The Farmers get supply from 6 to 8 hours – but there are frequent break downs. Due to delay in rain-Speed or drought- Farmers demand for energy is increasing –Further efficient energy supply (24 hours) is needed for local Processing of Agro-produce. There are huge transportation –losses and theft in electrical Supply lines

**Impact of Climate Change:** The Climate change has increased water and energy related, already existing shocks, in the arena of Climate Change, temperature is rising; monsoon is becoming more irregular with long dry spell and incidence of heavy rainfall in one day. This has adverse impact. The Agriculture productivity is directly related with Soil Moisture and availability of timely water and same is true for livestock, the milk yield, the poultry yield goes down. Country is already seeing this impact on decline of Food productivity and production and run for drinking water, both in urban and rural areas. Hence for Food Security, the water security is must and a prerequisite. It is this context; we need to examine availability Water and Energy and its use.

The Mint News paper has brought Out recently two interesting articles on 26-27of April 2016 which provides some interesting facts.

Drought in India –Current year affecting 33 cores in 256 districts. India’s average water footprint both direct and indirect use of surface/ground water, for major crops – wheat, paddy, maize, sugarcane and cotton is higher than global average. And there is inefficient use of water.

The report observes that the important States have inefficient use of water of following major crops:

- Andhra Pradesh - Rice, maize, cotton
- Gujarat - Cotton
- Maharashtra - Maize, sugarcane, cotton
- Karnataka - Maize, sugarcane, cotton
- Punjab - Wheat
- West Bengal - Rice

- Madhya Pradesh - Wheat
- Uttar Pradesh - Rice

Country as a whole is using water insufficiently. Further India has less than average per capita water footprint.

The Mint News Paper – 27<sup>th</sup> April 2016, writes how India is virtual exporter of water. The study has calculated quantum of water used for production in Agriculture and by livestock. According to Water Footprint Network (WFN). It takes 2173 litres of water to produce a KG of rice. In 2014-15 India exported 37.2 lack tons of Basmati. To export this rice, Country used 10 trillion litres of water or alternatively it exported water equivalent to that quantity. Similar is the situation for Dairy and Meat products. E.g. in case of goat meat, per kg requirement goes up to 8763 litres.

Since we do want to Export our Agriculture produce, the major policy implication is to introduce efficient use of water resources.

As regards water availability various studies have revealed that underground water sources are depleting and enhancing penetration of saline water of sea through faults both underground and over ground. The impact is in Gujarat and elsewhere. The recent study by Prof. Jay Famiglietti using NASA Satellite called GRACE reveals that in India – Rajasthan, Punjab, Haryana region is losing about 17.7 kilo meters of ground water per year (Times of India – 1<sup>st</sup> May 2016) Hence water conservation and its efficient use is the key for solution of obtaining water security.

Some examples of other inefficiency in use of water resources are:

- Majority of farm irrigation is flood irrigation. Water gets wasted in soil-areas where it is not needed. Whether it is from underground tube well or canal irrigation, water gets spread through entire farm. Drip irrigation exists – but to very limited areas.
- The public irrigation system – Canals are all open subject to evaporation with increased temperature and long dry spells. Actually this reduces available water resources drastically.
- We do not have yet standardized actual need – quantum of water needed for first, second or third irrigation for crop, plant or fruit tree or for that matter livestock (depending on its weight). In many a cases, excess water is given then needed. There is a need to calculate this and give farmers Agro advisory.

- Another important factor is the entire canal irrigation water is almost free and energy charges for pumping water are heavily subsidized. Hence there is tendency to waste. The value of water as a scarce resource is unknown. Even in urban areas, there is no control in use of water – like having water meter.
- Further there are recurrent floods now even in dry land areas. Historically, Uttarakhand, Uttar Pradesh, Assam and many other parts were affected by floods. This is resulting into a huge lose to both of human beings, property and erosion of infrastructure and soil Apart from affecting livelihood of people. It also results into lose of sweet water every year. While the areas of Saurashtra, Kutch, North Gujarat and Vidarbha Maharashtra are most often affected by water scarcity. But due to Climate change even in these areas there are days of heavy rain in last few years causing instant flood. Management of flood is an important policy matter. But due to lack of care, even water is wasted due to many other reasons which become the cause of flood!
  - Silting in check dam/Dams
  - Silting in river valley
  - Silting in river bed
  - Growth of bushes and leakage in canal
  - In correct data about absorbing capacity of river
  - Data about sea-water-level not coordinated
  - Soil erosion in river basin area
  - Data about sedimentation – old
  - Flood level not marked
  - Encroachment on river- side.

In fact all these Cause Flooding which did not exist.

### **Wastage of food**

While we are producing enough Food-today-but in recent past there has been decline of food production due to adverse climate condition. But on other head there is huge food wastage-at production stage and by consumers- When they are using it.

- **Farmers:**

The Farmers with little more care, education and support can save 5% to 25% of his produce which is lost due to inefficient methods:

- While harvesting.



- Cleaning (thrashing on road side).
- Packaging (in bags with holes).
- Transporting-putting his produce with other item – like gasoline or kerosene or having his product at bottom and others piled up – resulting into spoilage.
- Due to heat wave.
- UN seasonal frost.

If proper inter-connected chain is developed-so that his produce is collected from farm to packaging station and then to market yard, these losses can easily saved and his income enhanced up to 25%.

- **Consumers:**

There are several stages. Again improper storage and further transportation from market yard to whole-solar-to retailer due inefficient handling and improper packaging huge losses are taking place.

The concerned citizens also make waste-by peeling of vegetables more than needed, cooking more than needs of Family and throwing away. But huge wastage is in parties- dinners- and in restaurant – people take more in their plate then they can consume. For last one – a regulatory framework needed.

### **Gujarat Approach**

In fact, since seventies, country has excellent drought relief policy and introduced Drought Prone Area Programme backed by Watershed Approach. Gujarat went further and laid water pipeline connecting almost all affected villages with Narmada water and even inter linked rivers. These approaches have paid rich dividends very briefly:

#### **Water**

- Only 20% of area accounts for perennial rivers-80% is dependent on surface water. Gujarat is water starved state to Rajasthan in India.
  - Gujarat adopted certain innovative approach to meet this challenge.
- Integrated approach for sustainable and efficient water resources development by
- a) Water conservation –dams-check–dams, watersheds, borri bandh, village ponds-Farm ponds.

- b) Inter linking of river and canals – like Narmada canal with Sabarmati River.
- c) The Sardar Sarovar Dam on Narmada river- which is linked by canals water for irrigation to water-starved districts and also providing water to urban areas and Narmada water pipeline is linked 11000 villages in water starved area to meet drinking water requirement of human beings and cattle.
- d) Gujarat has adopted Participatory approach: The check – dams, water-sheds, minor-irrigation canals are under participating approach- right from construction to maintenance and management of its use by village community. More than 1, 00,000 check dams have been constructed under this approach.
- e) Milro- Irrigation is propagated – Government has set up an independent organization for mass introduction of drip and sprinkler irrigation known as Gujarat Green revolution Co Ltd- which is providing subsidies for laying of drip irrigation and its maintenance for three year with insurance cover and guiding farmer for its use and maintains and monitors its implementation.

As a result of above approach while ground water level of many states have declined in recent years, the Gujarat is an exception.

## **Energy**

Gujarat Introduced took a bold approach to provide electricity to rural areas under Jyotir Gram Yojana.

- It provided three phase power for 24 hours in rural areas. It introduced normal electricity tariff for residential area of village. It continued subsidized electricity to agriculture for eight hours. It created two different greed- one for residential area and another agriculture area. Hence now its entire village has 24 hours electricity. This has encouraged local processing of agriculture products and improved quality of village life and that of students who can study at night also and has also reduced migration.
- Solar Pumps: This is an innovative project who can study can evening and night to use solar energy in Dhundi village of Anand district –by Setting up Dhundi Solar Pump Irrigation Cooperative.
  - Install solar pumps for pumping of water.
  - Use solar panels for producing electricity.

When pump is not used, panels are linked with local electrical greed and farmers are paid for electricity produced.

This provide permanent source of Income (case study at annexturs)

The most important point to keep in view that despite all above and a very strong Climate Resilient Agriculture developed under Krishi Mahotsav approach –in last two years-due to drought and adverse Climatic Condition which included heat wave , Frost , the food production in Gujarat had declined so has position of water in major dams which got dried up and many village were required to be provided drinking water by tankers .

### **Way Forward**

With increasing adverse climate events and rapid urban development, new challenges are required to be addressed and ways focused to meet them.

- **Add value to water:** Water is becoming very scares. It is the key requirement for Food Productivity hence how to make it as a commodity with value – price as of now both urbanities and farmers get it almost free.
- **Introduce compulsory water cycling in urban areas:** How to control new Urban Township – they consume huge underground and canal water resources? How to introduce compulsory recycling of water both in Urban – Rural areas and make it available irrigation. Where this is not feasible, can we have compulsory “Recharge of water?”
- **Micro Irrigation:** Make drip irrigation – a way of life in farming.
- Can we decide to have ‘piped’ canals instead of current open system or replace it? Can we learn from Israel or from our own traditional water conservation system like that of “step well or tunnels”?
- **Safe Drinking Water:** How to ensure safe drinking water even in years of drought.
- **Solar Energy:** The pilot project at Anand Show the way. It was solar energy initially to pump water-but more to produce electricity which can be linked to local greed and farmers get paid first. The case Study is at annexative. This need to be replicated.
- **Use Biodiversity – Salinity Resistant/loving crops and trees:** How to use bio-diversity, identify salinity resistance crops and propagate them.
- **Village level water plan:** Can we introduce micro-level Water, Energy Agriculture production plan for every Village and Block.
- **Flood Prope Area Development Policy:** Every year we lose water in very many parts of our country, due to Flooding of rivers now even Fields.

## CONCLUSION

Climate change impacts the extent and productivity of both irrigated and rain fed agriculture. Rising temperatures will translate into increased crop water demand, so will be demand of increasing Urbanities. Both the livelihoods of rural communities and the food security of a predominantly urban population are therefore at risk from water-related impacts linked primarily to climate variability. Increasing soil salinity is already affecting the root zone and hence productivity. Management of saline water ingress is the third dimension of impending challenges. The rural poor, who are the most vulnerable, are likely to be disproportionately affected, so will be their livelihood. Various adaptation measures that deal with climate variability and build upon improved land and water management practices conservation and its efficient use have the potential to create resilience to climate change and to enhance water security. In order to meet the challenge of Food Security, first, there is a need to understand the need of efficient use of water and energy. In addition to existing programmes, there is a need to educate and make responsible citizen including our Public Leaders about value that water energy and reduction of wastage of food will have in years to come – its likely scarcity and impact on livelihood and Food Security both of urban and rural population. And also importantly on social tranquil and tensions resulting into water riots!

It must be mentioned that some of above approaches like above do exist – but time has now come to identify ‘inefficiencies’, ‘Gaps’ new technology serious understanding of problem related food , water and energy quality due to Climate Change inter connection. That is way Nexus approach is reduced.

## References

- High and Dry: Climate Change, water and the economy. The World Bank 2016.
- The Nexus approach to water energy – food security, an option for adaptation to Climate Change: International Centre for Integrated Mountain Development – Kathmandu – Nepal – 2015.

- Climate change and Ground water: India's opportunities for mitigation and adaptation. Dr. Tushar Shah, international Water Management Institute, Colombo, Sri Lanka – August 2009.
- The water Energy – Food Nexus – A new approach in support of Food Security and sustainable agriculture – FAO 2014
- Adapted from a comparative analysis of Turrall et al., 2011; Comprehensive Assessment, 2007.
- adapted from Climate Smart Agriculture Source, FAO 2013
- Kirit N Shelat. Climate smart agriculture, the way forward: The Indian perspective. *Climate Change*, 2015, 1(2), pp. CC1-CC184
- Climate Smart Agriculture – The Way Forward - The Indian Perspective – Edited by Dr. Kirit N Shelat and published by National Council for Climate Change Sustainable Development and Public Leadership (NCCSD) in 2014

## Annexure Food –Water-Energy

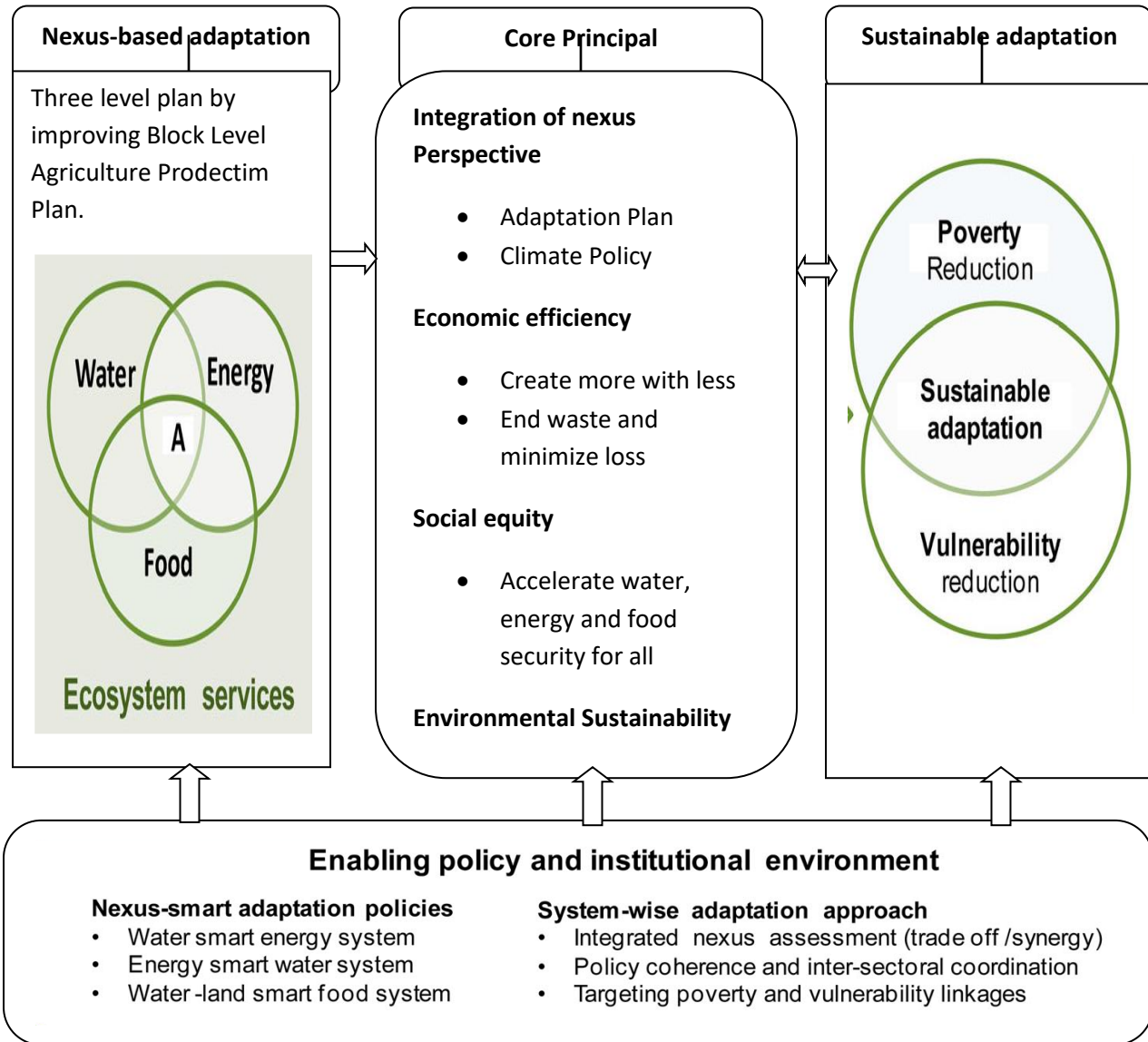


FIGURE Outline for a nexus-based adaptation framework  
Source: Adapted from Golam Rasul & Bikash Sharma (2015)