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Water, Food & Energy Nexus

ENVIS Team
Prabhat P Ghosh, ENVIS Coordinator
Vivek Tejaswi, Deputy Director
Ajeet Kumar Singh, Programme Officer
Pooja Kumari, Information Officer
Sarada Modak, Information Technology Officer
Mini Bala Bargayary, Ex- Information Officer
Ghazal Hashmi, Ex- Information Technology Officer
Sanjeev Kumar, Data Entry Operator

Editor
Prabhat P Ghosh
Vivek Tejaswi
Ajeet Kumar Singh
Ghazal Hashmi

Design & Compilation
Ghazal Hashmi
Pooja Kumari
Sanjeev Kumar

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Water–Food–Energy Nexus in Changing Agricultural Scenarios in Bihar

*Ghazal Hashmi**

**Research Associate, Centre for Studies on Environment and Climate (CSEC)*
Asian Development Research Institute, Patna.

Introduction

Water-Energy-Food Nexus (WEF) addresses the interconnection between the three vital resources to enhance daily livelihoods and promote socio-economic development[1]. The Nexus recognizes the availability of one that enhances the availability of another, as in the case of an increased supply of water in water deficit areas can increase food or energy production[2]. There is hardly any situation, where one of the three can be secured independently of the other. It offers an integrated approach, analyzing the synergies and trade-offs between the different sectors to maximize the efficiency of resource use[3]. The relationship is henceforth referred to as the 'nexus' between a set of competing demands and supplies. To produce more food and energy, and have sufficient water for the fast-growing population, which is projected to reach 9.5 billion by 2050, cross-sectoral coordination in support of sustainable management is uttermost important[4].

Agriculture is among the key sector which largely depends on the balanced WEF nexus. There is strong competition over water used for energy generation in terms of food production in water-scarce areas[5]. Figure 1 illustrates the conceptualization of WEF nexus relevance to irrigated agriculture. Introduced by the United Nations in 2015, SDGs are intended to be globally applicable and will need to be implemented by all national governments by 2030[6].

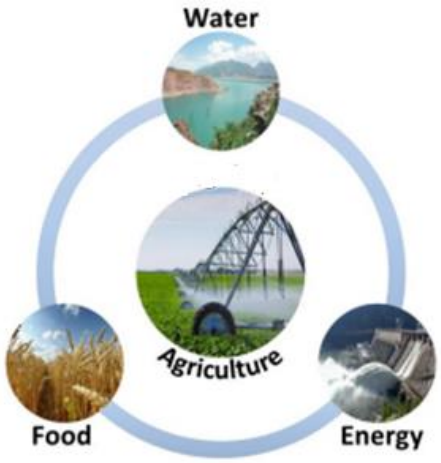

Figure 1- Water-energy-food (WEF) nexus in the agriculture sector

The nexus approach is particularly relevant to India, despite its rapid economic growth, which is suffering from water, energy, and food insecurity[7]Considering the critical position that agriculture occupies in the country's economy, ensuring food security for the population, providing livelihoods to the majority and indeed as a way of life for most rural people. The production levels of agriculture have remained low in the eastern region of India mainly due to a

lack of location-specific production technologies, natural calamities like floods, water logging, drought, inadequate supply of critical inputs, and social constraints.

Bihar is one of the important agrarian states of Eastern India. The crop yields are low and almost stagnating in Bihar compared to the north-western and other parts of the country. However, Bihar has increased secured supplies of water, energy, and food remarkably in recent years through policy interventions and investments in infrastructure[8]. It is endowed with abundant natural resources, especially fertile soil and groundwater. Bihar's per capita income (Rs 50,745 in FY20) is around 38 percent of all of India's average (Rs 1, 35,000 in FY20)[9], where agriculture is the prime source of wealth in the state and is the key to the overall development of the state's economy. Fertile Gangetic alluvial soils, and abundant water resources, particularly groundwater resources, form the basis of agriculture in Bihar[10]. The purpose of this study is to comprehend changes in agriculture over years in Bihar focusing on the connections among the nexus and potential challenges.

Structural Changes and Relative Performance of Agriculture in Bihar

Bihar's agricultural development in the last 10 years (2011-12 and 2019-20) presents a mixed growth pattern. Agricultural growth was around 9.6 percent in 2012-13, which was above the national average of 1.4 percent and in the latest five years, its performance was even more commendable, with an average annual growth rate of 7.1 percent. The agricultural growth rate in Bihar was 3.1%, slightly lower than the all-India agricultural growth rate of 3.4% during the period from 2001–02 to 2017–18[1]. Agricultural growth in Bihar has been very volatile in these years as can be seen in Figure2. The volatility is the result of recurring floods alternating with droughts. This shows the very complex nature of the water-food-energy nexus with some of it pulling and pushing the agriculture sector.

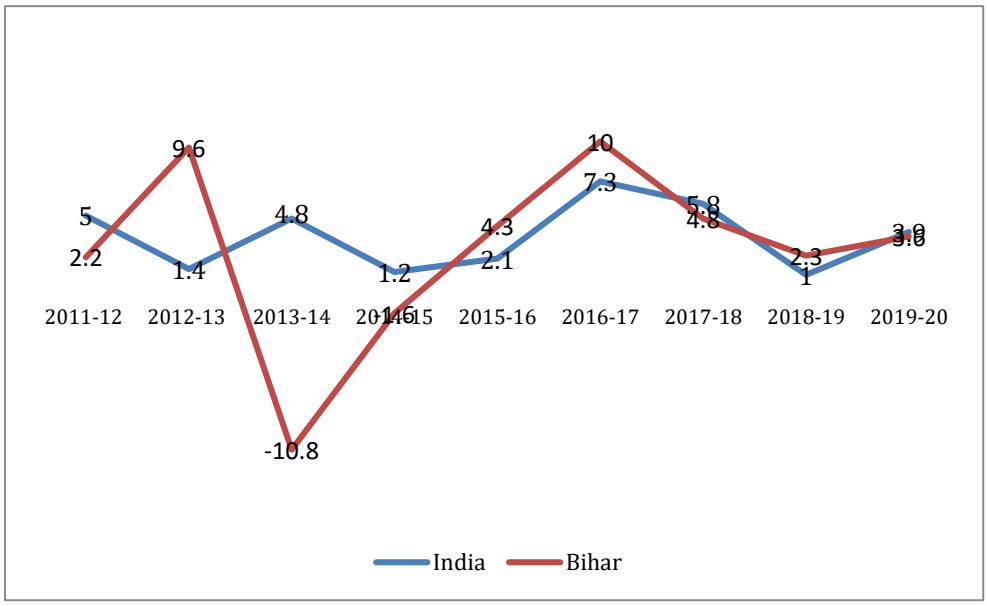

Figure 2– Agricultural growth rate of GSDP (2011-12 to 2019-20)

Source-Bihar economic survey 2019-20

Agriculture and Food

Change in Land Use

Bihar has highly fertile land falling in the Gangetic plain. However, a significant part of the North Bihar is prone to floods while, at the same time, some parts of South Bihar are subject to drought. Bihar has 9.4 million hectares of reported geographical area. Out of this, over 55 percent of the land is utilized for cultivation.

Table 1- Land use statistics of Bihar

(in thousand hectares)

Land use	2008-09	2018-19
Geographical area	9359.57(100.0)	9359.57(100.0)
(1) Forests	621.64 (6.6)	621.64 (6.6)
(2) Barren and Unculturable Land	431.77 (4.6)	431.72 (4.6)
(3) Land put to Non-agricultural use	1670.45(17.8)	1781.31 (18.4)
(4) Culturable Waste	45.43 (0.5)	43.85 (0.5)
(5) Permanent Pastures	15.87 (0.2)	14.98 (0.2)
(6) Land Under Tree Crops	242.86 (2.6)	248.49 (2.7)
(7) Fallow Land (excluding current fallow)	122.30 (1.3)	118.37 (1.3)
(8) Current Fallow	655.17 (7.0)	994.81 (10.6)
Total Uncultivable Land (1 to 8)	3805.48(40.6)	4192.41(44.8)
Net Sown Area	5554.08(59.4)	5167.15(55.2)
Gross Sown Area	7670.95	7406.38

Source: Land Use Statistics, DES, Ministry of Agriculture and Farmers Welfare

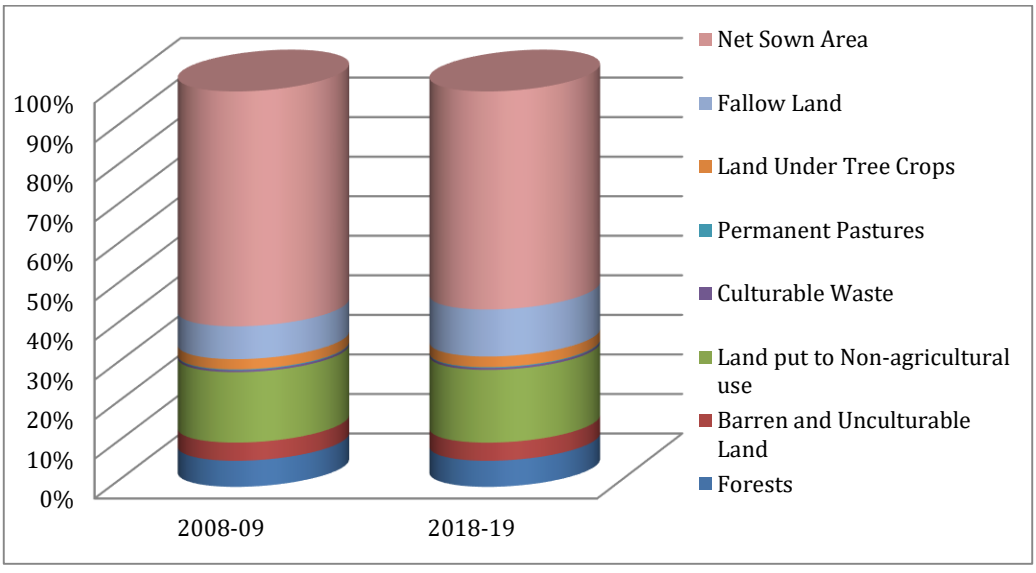

Figure 3- Land use pattern in Bihar

Source- Ministry of Agriculture and Farmers Welfare

Figure-4 shows a decadal increase from 2008-09 to 2018-19 inland use patterns. The cropping pattern shows a marginal improvement of 0.5 percent in a decade, from 1.38 in 2008-09 to 1.43 in 2018-19. However, during recent years, the net sown area has declined due to an increase in the fallow land and the area under non-agricultural uses. The increase in fallow land is generally

due to the lack of adequate irrigation water, labour shortage, and water logging due to floods. However, the rise in the proportion of fallow land is an issue of concern as there is a tendency to convert the fallow land into plantation crops or non-agricultural uses[11].

Change in Crop Production

The cropping pattern in the state is largely determined by biophysical and climatic factors, irrigation, technological adoption, and the socio-economic capability of the farmers. The pattern of land use and cropping system has implications not only for food and nutritional security but also for environmental sustainability. The agro-climatic and topographical factors in Bihar have led to the cultivation of cereals, pulses, oilseeds, fiber, and cash crops. Figure-5 presents the cropping pattern in the state during 2010-11 to 2019-20. Cereals dominate the cropping pattern in the state, occupying more than 86 percent of the gross cropped area[3].Both oilseeds and fibercrops have seen a steady decline in their share in the gross cropped area in the last five years. The large share of food grains in the total gross cropped area at 94.1 percent in 2019-20 is indicative of the subsistence nature of agriculture in the state. As an important cash crop, sugarcane occupies 3.3 percent of the gross cropped area in 2019-20. Since crop production is mainly dependent on monsoon, stepping up irrigation facilities and other infrastructure can go a long way in bringing more land under cultivation in Bihar[12].

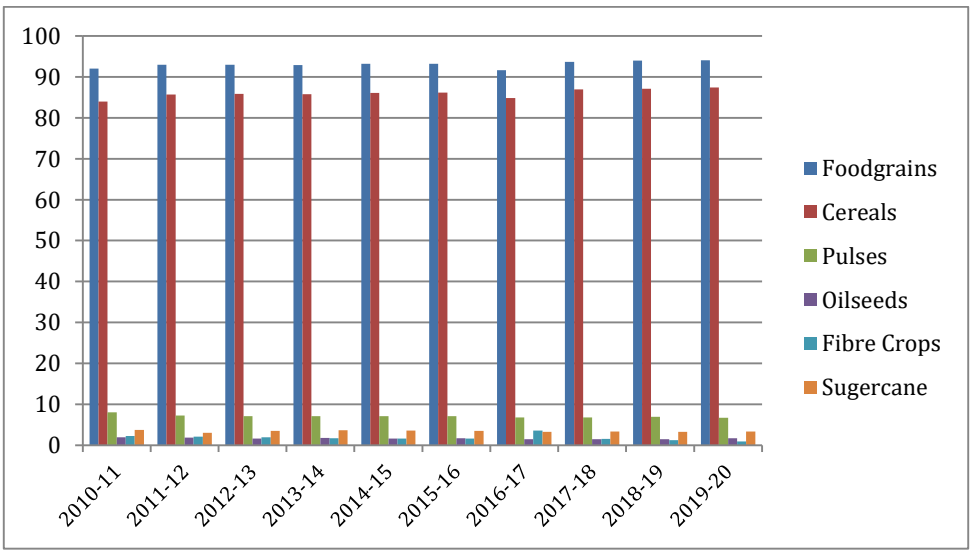

Figure 4- Cropping Pattern during 2010-11 to 2019-20

Source- Agricultural Statistics 2020

Agriculture and Energy

With the change in agriculture practices, technology and innovation has played a very crucial role in uplifting the agriculture sector as a whole. As necessary support to the advanced technology and processes, the role of energy has been observed very important. The sector has become energy-intensive; therefore, the reliability of the adequate power supply has become crucial to support essential processes like farm machinery, water management, irrigation, cultivation and

harvesting, and transportation. The availability of adequate and reliable power is crucial to energy pump sets for irrigation and other machinery.

Table 2- Power Consumption for Agricultural Purposes (2013-14 to 2020-21)

Years	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Power Consumption (in MU)	321.79	313.21	355.24	393.98	479.84	726.71	932.94	1243.72
Percentage in total power consumption	3.90	2.90	2.59	2.48	2.63	3.62	4.11	5.1

Source- Bihar State Power Holding Limited

Table 2 presents the trends in the use of power for agricultural purposes in Bihar during the period 2013-14 to 2020-21. During 2013-14, the agricultural sector is estimated to have used 321.79 MU of total energy and in 2020-21, it had increased to 1243.72 MU. In terms of the percentage of total energy consumption, there has been a steady increase from 3.90 percent (2013-14) to 5.1 percent (2020-21). Unmetered and free power can lead to inefficient and misuse of energy. The State Government has renewed existing units of power generation, transmission, and distribution to meet the growing demand for power for productive uses.

Power Availability for the Agriculture Sector

The spatial representation of change in farm power availability during 2014-17 is shown in Figure6. Out of 38 districts of Bihar, 20 districts have farm power availability which is more than the national average of 2.03kW/ha. In 2017, the top five districts with maximum farm power availability (kW/ha) were Patna (6.34), Jehanabad (5.73), Munger (5.42), Nalanda (4.89), and Gaya (4.62). Supaul district had the lowest farm power availability of 1.03 kW/ha in 2017[8]. State Government initiatives in the form of subsidies to various farm power machines, popularization of farm machines, and mechanization fairs in each district of Bihar have resulted in increased mechanization in the eastern region[13]. However, there is a need to develop and popularize solar-based technologies especially for community irrigation to reduce dependency on diesel fuel and ensure environmental sustainability.

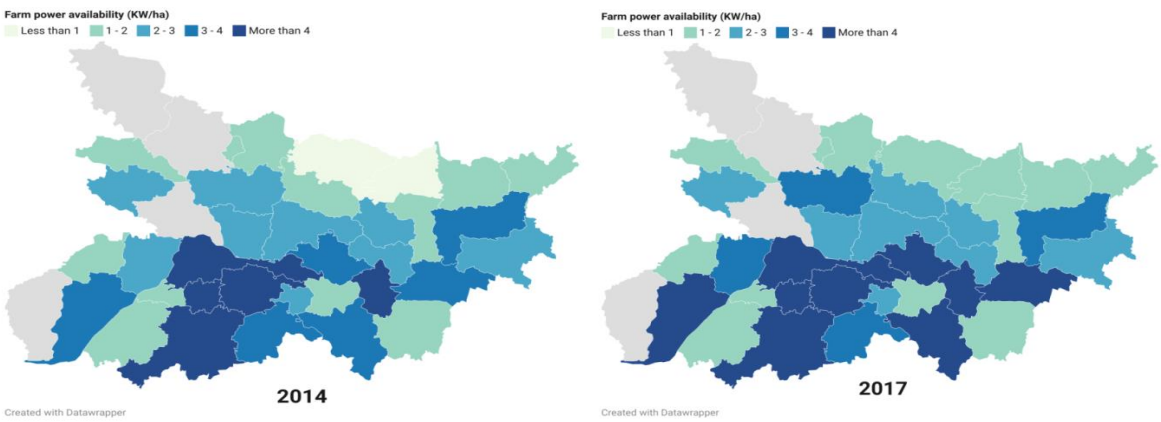

Figure 5- Spatial representation of farm power availability dynamics in Bihar (2014-17)

Agriculture and Water

Change in Irrigation Pattern

Irrigation plays an important role in raising crop productivity. The state of Bihar has rich groundwater as well as surface water resources. The irrigation sector in the state, however, faces the twin challenges of periodic occurrence of floods in the northern region and poor development of facilities for groundwater recharge in the southern region. Despite these challenges, the total irrigated area has increased considerably over time due to the concerted efforts of both the Central and state governments in implementing irrigation and flood control programs. In Bihar, the water area constitutes about 3.6 percent of the total geographical area. On average, the state receives annual rainfall amounting to 1000 mms, the bulk of which comes from the southwest monsoon[14]. However, erratic rainfall patterns and recurring droughts leading to scarcity of water for irrigation have affected achieving higher productivity.

Therefore, a well-planned irrigation system is needed to assist in stabilizing production, and improving yield and cropping intensities. Indeed, in recent years, erratic rainfall patterns, recurrent droughts, and over-exploitation of groundwater have emerged as major challenges to achieving water use efficiency in Bihar[4].

Table 3- Source of Irrigation in Bihar (2011-12 to 2017-18)

Year	Canals	Tanks	Wells			Other Sources	Total
			Tube wells	Other wells	Total wells		
2011-12	1473.48	74.09	3402.64	28.84	3431.48	178.46	5157.51
2012-13	1521.73	72.74	3516.83	29.37	3546.2	186.3	5326.97
2013-14	1470.88	73.54	3401.36	28.27	3429.63	170.72	5144.77
2014-15	1490.08	73.7	3497.44	29.58	3527.02	176.73	5267.52
2015-16	1466.07	84.57	3482.18	28.60	3510.78	185.43	5246.85
2016-17	1628.97	107.27	3377.1	37.57	3414.67	190.56	5341.46
2017-18	1660.00	104.88	3418.26	39.63	3457.89	190.74	5413.51
CAGR(%)	1.37	7.25	-0.16	5.34	-0.10	1.14	0.61

Source: Economic Survey of Bihar (2017-18 to 2020-21)

During 2017-18, Bihar received an annual rainfall of 994.4 mms, out of which 84.9 percent was largely due to the southwest monsoon[15]. However, this is not adequate to water the entire farming activities in the state.

The source-wise irrigation (percent of the gross irrigated area) for the period 2011-12 to 2017-18 is presented in Table 3. The gross area irrigated in the state has increased to 54.14 lakhs during 2017-18, compared to 51.58 lakh hectares in 2011-12, showing an increase of only 4.7 percent. Tube wells are the largest source of irrigation in Bihar, contributing to about 63.1 of the total

gross irrigated area in the state, while the second most important source is irrigation canals (30.7 percent). The gross irrigated area under tanks increased from 0.74 lakh hectares in 2011-12 to about 1.05 lakh hectares in 2017-18, registering an annual growth rate of 7.25 percent. The growing share of tube wells in irrigation is of concern because it leads to over-exploitation of groundwater and fall in water tables.

Irrigation Potential of Bihar

The irrigation schemes in Bihar can be broadly divided into major, medium, and minor irrigation schemes. Figure-7 presents the status of irrigation potential in Bihar for 2019-20. Out of the ultimate irrigation potential of 117.54 lakh hectares in Bihar, the irrigation potential has been estimated to be 53.53 lakh hectares for major and medium irrigation schemes, while it is 64.01 lakh hectares from minor irrigation schemes. Further, the groundwater resource accounts for about 75.9 percent (48.57 lakh hectares) of ultimate irrigation potential.

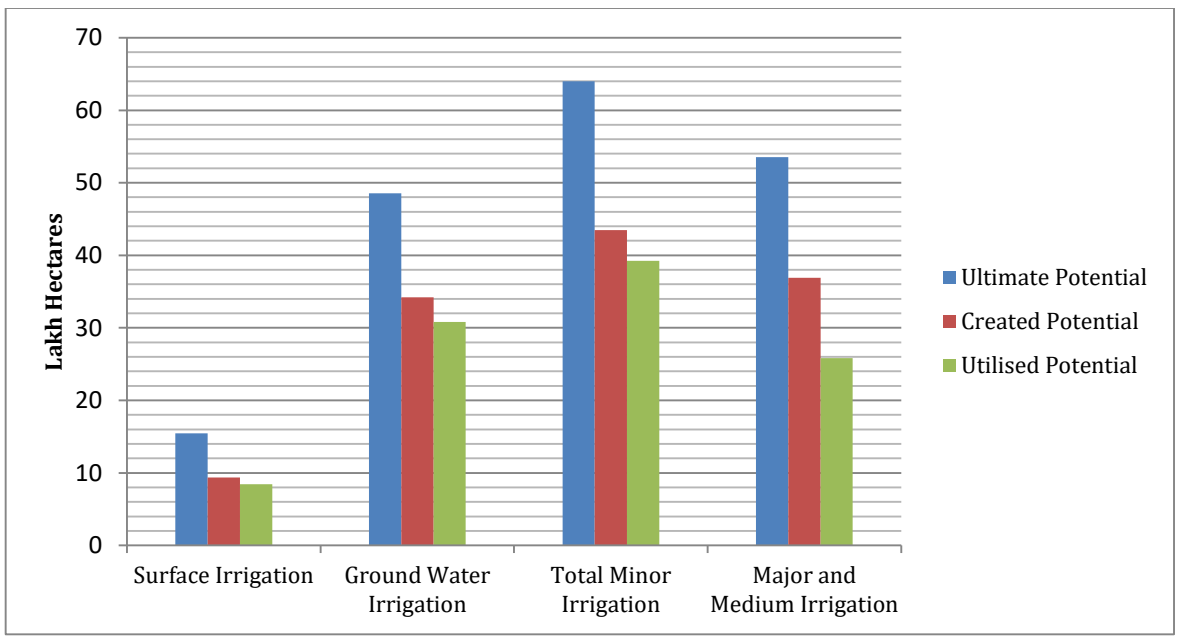

Figure 6- Status of water resources in Bihar (2019-20)

Source: Economic Survey of Bihar (2017-18 to 2020-21)

Groundwater Utilization for Irrigation

The total annual groundwater extraction of Bihar in 2020 has been estimated as 25.46 bcm[14].The agriculture sector is the predominant consumer of groundwater resources. About 89% of total annual groundwater extraction i.e., 221.46 bcm is for irrigation use. Only 27.24 bcm is for Domestic and Industrial use, which is about 11% of the total extraction. The overall stage of groundwater development in the country is 63% while in Bihar it has reached up to 50%.

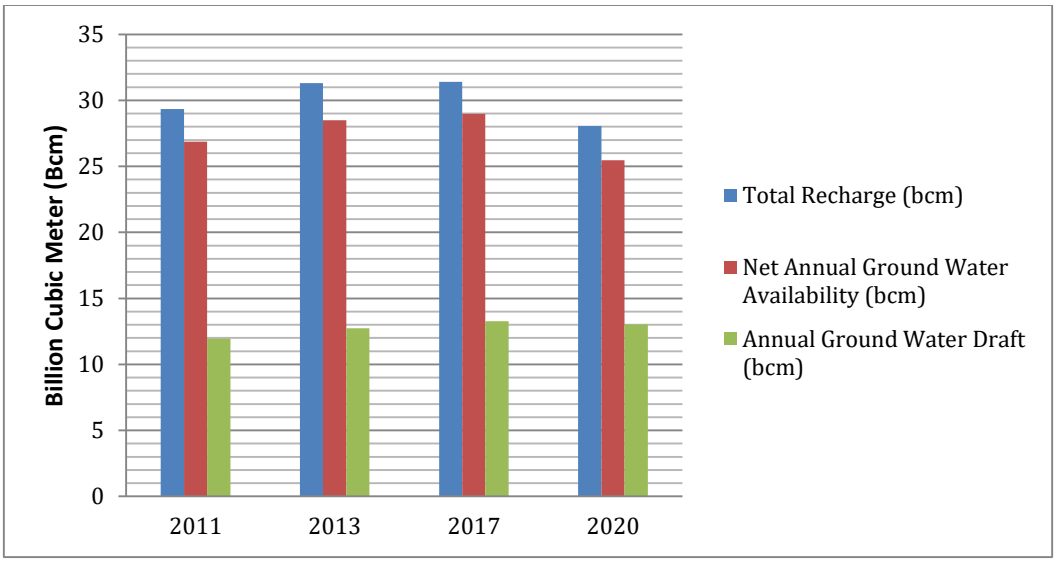

Figure 7- Groundwater resources availability and utilization

Source: Dynamic Groundwater Resource of India 2020

Figure8 shows the comparative picture of the water level fluctuation from 2010- to 2019 after the monsoon. It has been observed that the groundwater level has been declining in south Bihar and certain pockets in north Bihar as well. About 39% area of the state has shown a fall in water level which covers a major part of the districts located in Kosi mega-fan and also Banka, Aurangabad, Rohtas, and Arwal districts.

Conclusion

A comprehensive set of analyses is presented which assess the present status of the water– food–energy nexus in Bihar, along with its changing pattern in the last decades. With the growth of population and consequent increase in the food demands, food production has also increased, and this has been made possible with the intensification of the irrigation system. However, during the recent decade, there has been an excessive increase in groundwater utilization for irrigation which is leading to a drought-like situation in major parts of the stage. The electricity usage for agricultural purposes has an increasing trend and, interestingly, it also reveals an important finding that irrigation has been intensified irrespective of rainfall. This also resulted in a decreasing correlation between food production and monsoon rainfall, revealing the increasing dependency of agricultural activities on irrigation. Irrigation has now become essential for agriculture to meet the food demand; however, it should be judiciously regulated and controlled, based on the water availability from monsoon rainfall, specifically after the drought years, as it is essential to recover from the deficits suffered previously. This all puts additional pressure on water, energy, and food resources and interlinkages among them. Meeting the growing water and food demands in a densely populated state like Bihar is a major challenge. It requires an extensive investigation into the changing patterns of the checks and balances behind the maintenance of food security at the expense of depleting groundwater, along with high energy consumption.

Therefore, understanding the water-energy-food nexus interlinkages is extremely important to address the challenges that those regions are facing.

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Case Study

Food Security in India

The United Nations Committee on World Food Security defines food security as "physical, social, and financial access to adequate, safe, and nutritious food that meets their dietary needs and food preferences for a functioning and solid life consistently." According to this definition, food security consists of three components: food accessibility, food access, and food assimilation, implying that adequate food production is unquestionably not an adequate requirement for a country's food security. India is a country full of extremes. In total, 22% of the population lives in poverty[1]. At the same time, it is home to 84 billionaires from around the world[2]. The top 1% of Indians hold more than half of the country's wealth. It is the world's second-largest food producer, but it also has the world's second-largest population of undernourished people[3].

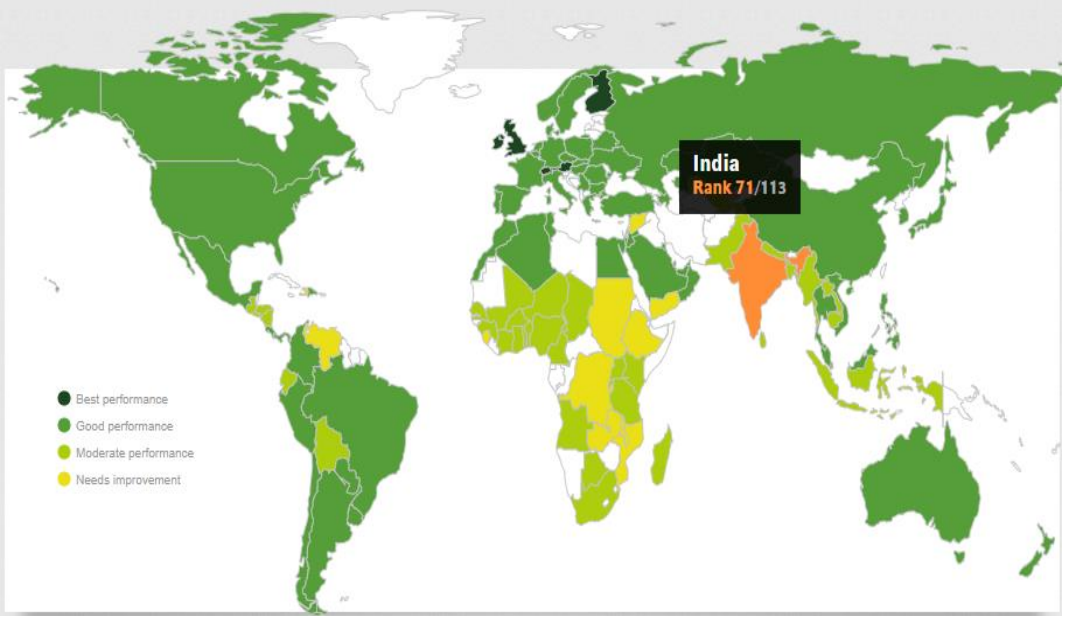


Figure 8- Food Security Index 2021

[1]*Bhalla, S. S., Bhasin, K., &Virmani, A. (2022). Pandemic, Poverty, and Inequality: Evidence from India, WP/22/69, April 2022.*

[2]*https://www.forbes.com/sites/luisakroll/2016/03/01/forbes-2016-worlds-billionaires-meet-the-richest-people-on-the-planet/?sh=29179e7677dc*

[3]*Fao.(n.d.). The State of Food and Agriculture 2015 (SOFA): Social Protection and Agriculture: Breaking the Cycle of Rural Poverty.*

Since India is the world's second-most populous country, food security has always been a primary priority for the country. Regardless of government efforts and the country's relatively rapid financial development, hunger and malnutrition remain a problem. Despite the fact that food is one of the key objectives in the 2030 Agenda's Sustainable Development Goals (SDGs), with food markers in around 12 of the 17 SDGs, the country is currently unable to achieve the Millennium Development Goal of reducing the number of hungry people. The Global Hunger Index (GHI) 2021 report has put India at 101st among 128 nations which is a drop from the 94th situation in 2020, much behind Bangladesh, Pakistan, and Nepal[4].

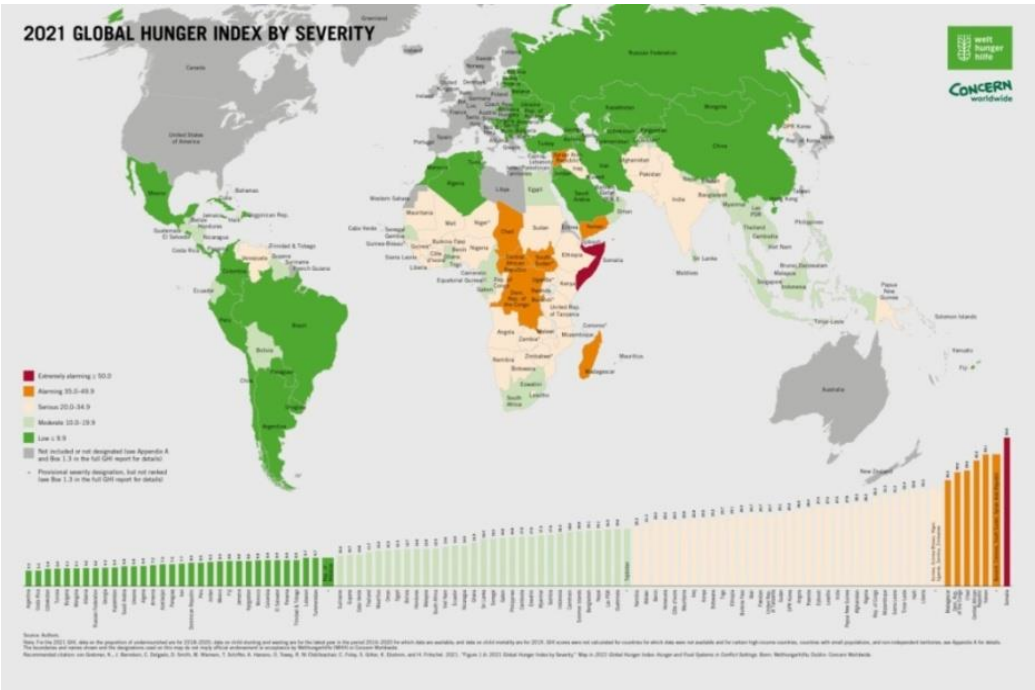


Figure 9- Global Hunger Index 2021

The goal of achieving Zero Hunger and Malnutrition is to ensure that no one is left behind in the quest for food and nutrition security. In India, this will include significantly bettering the health of mothers and children. Food security, which is influenced in a variety of ways, is perhaps the most pressing challenge related to environmental change. In India, a large portion of the country relies on groundwater for its water supply and is currently experiencing water scarcity. Huge swaths of northwestern India, most notably Punjab and Haryana, which produce the majority of the country's rice and wheat, are very water-intensive. The environmental change has additionally constrained the tanks and wells to go dry and the streams to recoil while the other more modest waterways have

[4]*https://www.globalhungerindex.org/india.html*

gone dry in states like Punjab, Haryana, and Andhra Pradesh. To address the dual concerns of climate change and food insecurity, creative and innovative responses are required. 'Transformative adaptation,' defined as enhancing long-term resilience by altering a system's essential features in response to real or anticipated climate change and its repercussions, could be part of the solution to this dilemma.

The following are the three types of transformative agricultural adaptation activities that are being implemented in different parts of India:

- Relocation of entire crop and livestock systems to different locations.
- To align crop and livestock production to changing ecosystems and natural resources.
- To adopt new technologies that change the existing agricultural production in significant ways

Himachal Pradesh*- As winter temperatures rise, apple production decreases in the state, as a result, apple farmers are shifting towards higher altitudes for more favorable temperatures and are intercropping with vegetables and fruits such as tomatoes, peas, broccoli, kiwis, and pomegranates at lower altitudes.*

Maharashtra*- Due to declining levels of groundwater and rising input prices, farmers in drought-prone areas are switching from grapes to pomegranates.*

Gujarat*- Farmers along Gujarat's coast is switching to aquaculture due to seawater intrusion on fertile land preventing them from growing paddy and other crops.*

Madhya Pradesh- *Unpredictable rainfall and deforestation significantly influence the lives of indigenous populations who rely on small-scale rain-fed agricultural and non-timber forest commodities. Strengthening institutions saved about 500 hectares of forest and implementing soil water conservation strategies saved over 37,000 cubic meters of soil, resulting in a 40% increase in annual average income.*

West Bengal- *Diversifying livelihoods of agriculture-dependent local communities in flood-prone areas of West Bengal have shown to be a successful adaptation measure. Beneficiaries' incomes have increased by 70-100 percent due to the establishment of integrated production systems that includes great range of crops, improved livestock breeding, poultry and fisheries.*

Tamil Nadu- *Floods, cyclones, and rising sea levels have caused erosion and salinization of land and groundwater along the coast. Adopting integrated mangrove and fish farming systems not only reduce the impact of cyclones but also generates additional revenue for families of up to 81,000 Indian rupees per year.*

Rajasthan- *The movement of dunes in the Thar Desert causes substantial damage to infrastructure and agriculture every year. An innovative approach of using multiple layers of indigenous vegetation helps in stabilizing dunes and improves the local economy by providing additional fodder, fuelwood, fruits, and vegetables as well as different types of minor forest produce.*

Water Security in India

India faces a serious and persistent water crisis owing to a growing imbalance of supply and demand, as well as poor water resource management and climate change. India is projected to face severe water stress by 2050 *(Figure-10).*

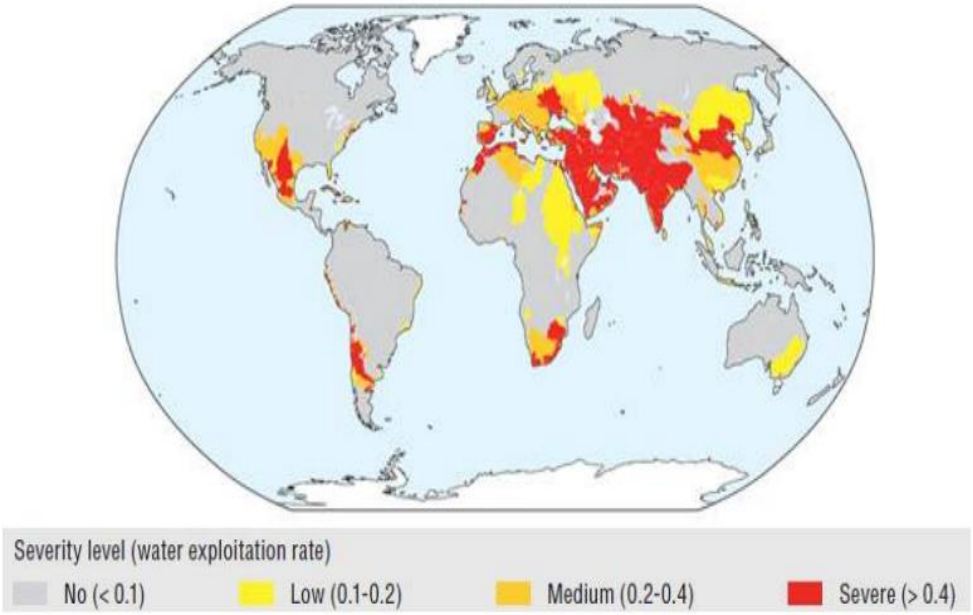


Figure 10- Water stress by river basin in 2050

Source: OECD (2012), Environmental Outlook to 2050: The Consequences of Inaction.

Agriculture consumes approximately 90% of India's water, being the largest contributor to the country's GDP. Groundwater is used to provide two-thirds of India's irrigation needs and 80% of domestic water needs, leading to the country's high groundwater depletion rate. Despite having one of the largest irrigation systems in the world, India has a high rate of inefficient water use[5]. The quality of the water is also a concern. The most significant source of water pollution in India is the discharge of untreated sewage into water bodies out of which eighty percent of sewage generated is not cleaned. Also, there is still a lack of access to improved water supplies and proper sanitation. According to the government census of 2011, only about 30% of the 167 million rural households in India have access to tap water and household toilets.

[5]*Fao.(n.d.).The State of Food Insecurity in the World Strengthening the enabling environment for food security and nutrition.*

The definition of water security proposed by UN-Water to serve as a starting point for dialogue in the UN system – "The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability[6]."

Improving India's water security is critical to its development. With overall water consumption predicted to climb by more than 70% by 2025 in India, a massive demand-supply gap is expected in the future years. This could be a huge stumbling block to economic growth. Concerns have also been raised about the alarming rate of groundwater depletion. Increased pumping costs and salty irrigation water as a result of over-abstraction of groundwater result in crop and financial losses for farmers, as well as long-term implications for water availability.

Water security is a comprehensive socioeconomic, environmental, and political challenge, not just a water one. To effectively manage the nexus of water, food, energy, and climate variability, all sectors must be encouraged and educated to consider water in their policies and strategies. This will enable sustainable socio-economic growth and political stability all over the world.

The Indian state of Bihar is experiencing a severe water shortage. It possesses prospective aquifers with abundant water supplies for recharging, but groundwater withdrawal has intensified in recent decades. According to a report conducted by the state's Public Health Engineering Department (PHED), at least eight of the region's 38 districts have drastically low groundwater levels. At least 11 of the districts are classified as "water-stressed." Despite being a land of rivers, more than 80% of irrigation demands in north Bihar are satisfied primarily by groundwater resources due to easy availability and an insufficient and inefficient surface water irrigation network. This unsustainable use of groundwater is made more difficult by (a) rising demand from a growing population and industrialization, which puts a strain on supply, and (b) the poorly understood effects of climate-driven changes in the water cycle, such as temperature rises and changes in rainfall patterns, which can affect groundwater recharge rates.

[6]*Bigas, Harriet., United Nations University. Institute for Water, E. and Health.,& Canadian Electronic Library. (2013). Water security and the global water agenda:an UN-water analytical brief. United Nations University - Institute for Water, Environment and Health.*

In the news

The Netherlands Expo pavilion makes its water to grow food in the desert heat

Netherlands' pavilion is itself a cutting-edge sustainable innovation, a structure whose centrepiece is an 18-meter-tall, cone-shaped vertical farm. The brainchild of Dutch architect MichielRaaphorst of V8 Architects, it's described as a "biotope" (basically, an area with a uniform biological environment) that aims to "unite energy, water, and food," allowing farming even in places where the temperatures are typically too high, like in the desert heat of Dubai.

Source:*https://dubaidaily.ae/the-netherlands-expo-pavilion-makes-its-own-water-to-grow-food-in-the-desert-heat/*

Failed Organic Drive Further Derails Sri Lanka's Shaky Economy

The Sri Lankan government is bailing out its farmers and being blamed for a food crisis, due to a ban on agrochemical and chemical fertilizers. President Gotabaya Rajapaksa introduced the ban in May 2021 to accomplish his ambitious goal of becoming the world's first completely organic farming nation. This failed scheme was part of a wider import ban that plunged the farming sector into crisis and was renounced months later. As exports of goods and services were hampered by the pandemic last year, Sri Lanka's trade deficit increased, eroding foreign reserves.

Source:*https://www.scoop.co.nz/stories/HL2203/S00007/failed-organic-drive-further-derails-sri-lankas-shaky-economy.htm*

Optimizing Phase Change Materials Could Reduce Power Plant Water Consumption

As the population grows, human demand for energy and food has caused freshwater reserves to slowly deplete. Power plants are one of the main culprits contributing to this issue, as they use trillions of gallons of freshwater annually to prevent overheating. A research group at Texas A&M University has shown that specific phase change materials (PCMs) can cool steam turbines used in power plants,

averting freshwater usage. Simultaneously, the group used machine-learning techniques to enhance the reliability and energy storage capacity of various PCM-based cooling platforms to develop powerful "cold batteries" that dispatch on demand.

Source:*https://www.enn.com/articles/68361-optimizing-phase-change-materials-could-reduce-power-plant-water-consumption*

PM-KUSUM scheme 70 percent government subsidy offered for installing solar pumps

PM-KUSUM (Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) Scheme is aimed at ensuring energy security for farmers in India, along with honoring India's commitment to increase the share of installed capacity of electric power from non-fossil-fuel sources to 40% by 2030 as part of Intended Nationally Determined Contributions (INDCs). It is one of the largest initiatives in the world to provide clean energy to more than 3.5 million farmers by solarising their agriculture pumps and allowing farmers to up 10 GW distributed solar projects. The scheme plans to set up 30.8 GW of solar capacity by December 31, 2022, through the financial assistance of INR 340.35 billion (USD 4.65 billion).

Source:*https://www.india.gov.in/spotlight/pm-kusum-pradhan-mantri-kisan-urja-suraksha-evam-utthaan-mahabhiyan-scheme*

Climate resilient agriculture systems: The way ahead

Indian Council of Agricultural Research (ICAR) and the Government of India launched a flagship network project 'National Innovations in Climate Resilient Agriculture (NICRA)' in 2011. The project aims at strategic research on adaptation and mitigation, demonstration of technologies on farmers' fields, and creating awareness among farmers and other stakeholders to minimize the climatic change impacts on agriculture. So far, 7 climate-resilient varieties and 650 district agricultural contingency plans have been developed besides assessing the risk and vulnerability of Indian agriculture to climate change. In the past nine years, 16,958 training programs have been conducted throughout the country under the NICRA project to educate stakeholders on various aspects of climate change and resilient technologies, covering 5,14,816 stakeholders to enable wider adoption of climate-resilient technologies and increase in yields.

Source:*https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1743354*

The groundwater table in a village in Karnal is now at 1,000 feet

Ardana is like any other Haryana village, located about 140 km from India's capital, New Delhi. According to the government, groundwater levels in this village in Karnal district have reached 40 meters (131.24 feet) but may have reached 304.8 meters (1,000 feet) if one believes the residents. The reason behind the extreme groundwater crisis in Ardana is the paddy-wheat crop rotation cycle, with farmers extracting water to grow water-guzzling paddy in what is a semi-arid environment. Ardana, along with 1,779 other villages, was classified as being in the 'Red' category. The Haryana government, which noticed the steep fall in the groundwater level of the state, launched a scheme three years ago. It was named Mera Paani, Meri Virasat (My water, my heritage).

Source:*https://www.downtoearth.org.in/news/water/how-paddy-affects-groundwater-table-in-this-karnal-village-is-now-at-1-000-feet-82050*

IPCC Report's Predictions for India: Drop-in Crop Production, Water Scarcity, and More

The Sixth Assessment Report (AR6) Working Group II (WRG II) report has identified India as the most vulnerable country in terms of crop production. Rice, wheat, pulses, and coarse cereal yields could fall almost 9% by 2050. In South India, maize production could decrease by 17% if the global temperature rise continues at a higher rate. The changing climate, coupled with rising demand, could mean that about 40% of the people residing in India will live with water scarcity by 2050, as compared to 33% of the population at present, according to a study cited by the report.

Source:*https://weather.com/en-IN/india/climate-change/news/2022-03-01-ipcc-report-2022-predictions-for-india*

Har Khet Ko Paani Under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched in 2015-16 to enhance physical access to water on the farm, expand cultivable areas under assured irrigation, improve on-farm water use efficiency, introduce sustainable water conservation practices, etc. Har Khet Ko Pani (HKKP) is one of the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) components. Under HP, financial

assistance is being provided by this Ministry under Command Area Development and Water Management (CADWM); Surface Minor Irrigation (SMI); Repair, Renovation, and Restoration (RRR) of Water Bodies; and Ground Water components.

Source:*https://vikaspedia.in/agriculture/policies-and-schemes/crops-related/pradhan-mantri-krishi-sinchai-yojana*

All farmers in Bihar will get separate electricity for farming under Deendayal Upadhyaya Jyoti Gram Yojana

The plan to provide separate electricity for agriculture can be completed this month. The work of separating dedicated feeders for farmers is now in the final stage. Although there may be some difficulty in completing this scheme in some areas due to floods in the state, the power company is trying to complete it, in any case, this month. After the completion of the scheme, from next month, all the farmers of the state will get separate electricity for farming. The scheme to provide separate electricity to the farmers of Bihar under Deendayal Upadhyaya Jyoti Gram Yojana was approved in March 2016.

Source:*https://www.livehindustan.com/bihar/story-bihar-all-farmers-will-get-electricity-separately-for-farming-3468227.html*

FSSAI report: Bihar ranks lowest in ensuring food safety

Bihar ranked the lowest among the large states in ensuring food safety in 2020-21, according to the Food Safety and Standards Authority of India (FSSAI) report released by the Union Ministry of Health and Family Welfare. The state's overall score was 35 whereas Gujarat topped with 75 points. The third edition of the State Food Safety Index ranked the states on five parameters of food safety which included human resources and institutional data (20% weightage), compliance (30%), food testing facility (20%), training and capacity building (10%) and consumer empowerment (20%). The ranking is an effort of the Union government to galvanize the states to work towards ensuring safe food for citizens.

Source:*https://timesofindia.indiatimes.com/city/patna/fssai-report-bihar-ranks-lowest-in-ensuring-food-safety/articleshow/86405757.cms*

Events

Special Lecture

Lecture I: Restoring Urban Ecosystems: a sustainable approach to mitigate the impact of ground-level ozone

To draw attention to a pressing issue of ground-level ozone, on the occasion of World Ozone Day, 2021 a special lecture with the theme being Keeping us, our food, and vaccines cool (towards slowing climate change and helping to boost energy efficiency in the cooling sector) was jointly organized by the Centre for Studies on Environment and Climate (CSEC) at the Asian Development Research Institute (an ENVIS Resource Partner of Government of India), and Patna Women's College on September 16, 2021. The speaker of the lecture was Dr. Umashankar Singh, IFS, Principal Chief Conservator of Forest (Retd), Department of Environment and Forest, Government of Uttar Pradesh, and Mr. Madhukar Swayambhu, Vice-President Community Friendly Movement, New Delhi.

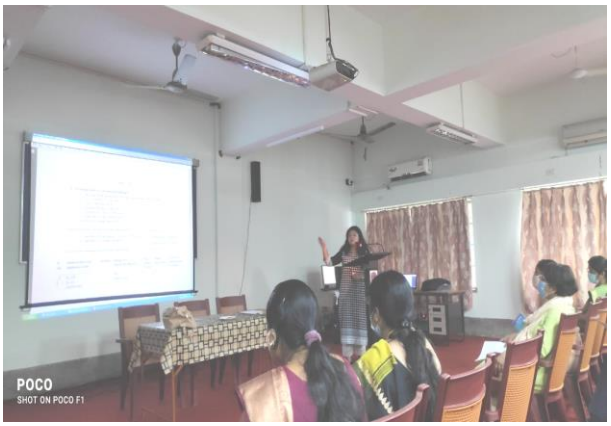
Available at: *https://www.youtube.com/watch?v=mQkXjIiJ2tQ*

Lecture II: Ground Water: Making the invisible visible

To highlight challenges around Groundwater Resources and to put a spotlight on this invisible resource, on the occasion of World Water Day, 2022 a special lecture was organized by the Centre for Studies on Environment and Climate at the Asian Development Research Institute (an ENVIS Resource Partner of Government of India) on March 22, 2022. The lectures were delivered by Professor Ashok Kumar Ghosh, Chairman of Bihar State Pollution Control Board (BSPCB), and Mr. Ranjan Panda, a Convenor at Water Initiatives Odisha (WIO) and Combat Climate Change, India.

Available at: *https://www.youtube.com/watch?v=-gyHr0w7MPA*

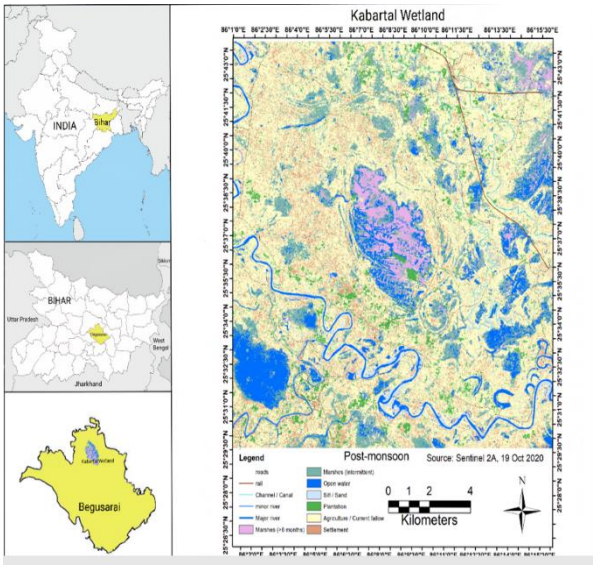
Training and Orientation for Green Audit at Patna Women's College



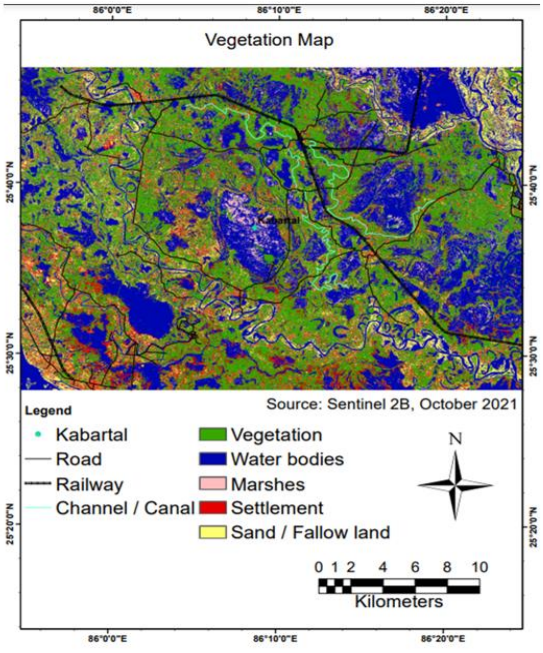
As part of the pre-audit specific schedules for training and orientation of the surveyors and faculty and administration, staff was made, whereby the stakeholders were oriented on the concept of green audit, the objective of conducting a green audit at PWC, the roles and responsibilities, the procedures of conducting the surveys of water, waste, energy and biodiversity sector and its compilation. To monitor the survey process and keep accountability of the surveyed data, a domain expert was chosen among the faculty members of PWC to guide volunteers during the survey process and share their observations and recommendations for the same. Post rigorous orientation and training, the surveyors conducted primary surveys from the four sectors on the campus. Thus, the data generated from the survey were analyzed to identify the best practices and gaps in environmental sustainability at PWC.

Knowledge Outcomes

Maps



Map 1: In July 2020, under the Ramsar Convention on Wetlands has declared the 'Kabartal', erstwhile known as Kanwar Jheel as the site of ecological hotspot, thus included in the 'List of Wetlands of International Importance', established under Article 2.1 of the convention. It is the 2436th such wetlands-based ecological hotspot site in the world. Kabartal is situated in the core of 18 feeding wetlands conglomerated in the peripheral regions. The entire wetlands complex absorbs excess water and get replenished every year during monsoon floods, with an average depth of 1.5 meters, where 70% of the land is vulnerable to its inundation. During the dry season, major areas under the complex dries out and provide essential ecosystem services to the dependent communities

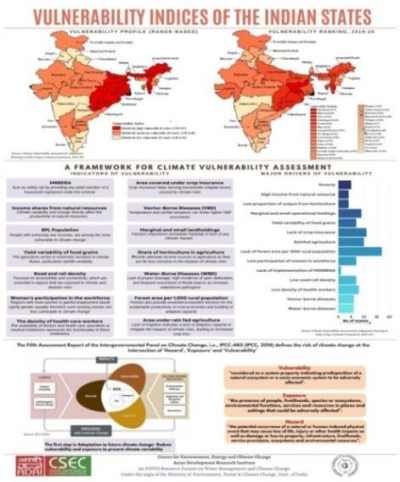


Map 2.10: Vegetation of Kabar Wetland Complex

Map 2: Macrophytes dominate the floral diversity of the Kabartal wetland. Of the 46 recorded species, 9 are submerged, 9 floating and 28 emergent macrophytes. The deeper areas of wetland that contain water for large parts of the year have submerged vegetation, of which Hydrilla verticillata, Vallisneria spiralis, Najas minor, Ceratophyllum demersum, and Potamogeton crispus are dominant.

During monsoon, submerged vegetation spreads to the areas of Simraha, Mangardaha, Bela and Barko. The rooted floating species, Nelumbo nucifera, Nymphaea stellata, Trapa natans are distributed all around the shallow region of the lake wherein water depth ranges between 0.5 – 1 m.

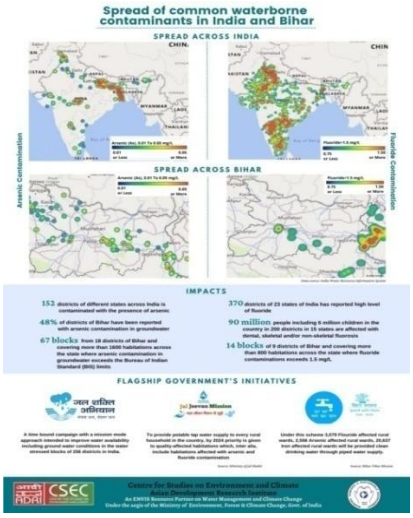
Infographics



'Vulnerability Indices of the Indian States'

To highlight the vulnerability indices of the Indian states based on the report of climate vulnerability assessment by DST India that identifies the most vulnerable states in India concerning current climate risk and main drivers of vulnerability.

Available at:
https://www.adriindia.org/publiications/brochures/32



'Spread of common waterborne contaminants in India and Bihar'

High concentrations of waterborne contaminants such as arsenic, and fluoride have not only impacted the environment but also become a major public health issue in India and Bihar.

Available at:
https://www.adriindia.org/publications/brochures/35

'Status of terrestrial biodiversity in Bihar'

The terrestrial animals of Bihar are mostly vulnerable and endangered. It is much needed to reverse the fate of these species to support the restoration of their habitats and ecosystems and promote their sustainable use by humanity.

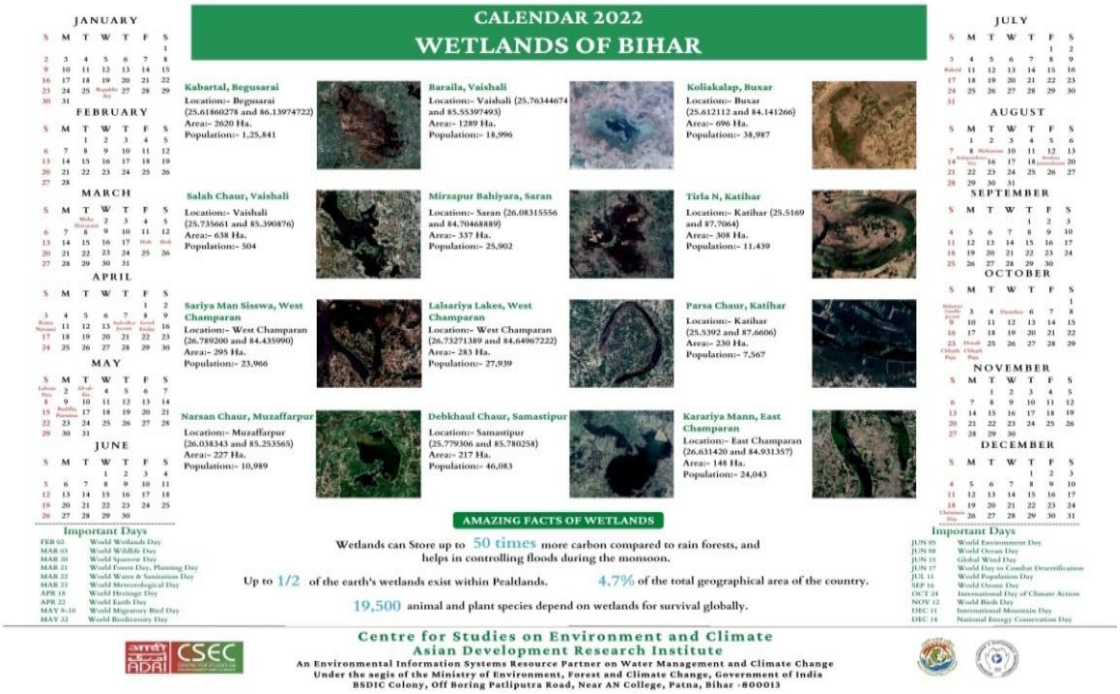
Available at:
https://www.adriindia.org/publications/brochures/37

'Status of aquatic biodiversity in Bihar'

The aquatic animals of Bihar are most vulnerable and critically endangered due to human threats. Efforts on the part of the people are much needed for sustaining their growth and survival.

Available at:
https://www.adriindia.org/publications/brochures/36

Calendar



Upcoming Events

Green Skill Development Programme

This year, the Centre will be conducting Green Skill Development Programme (GSDP) training on Biodiversity Conservation (NSQF Level 4, 420 hrs). The objective of this training is to provide basic knowledge of wildlife and riverine biodiversity, challenges, and methods of conservation to the target youths from the local community, individuals with genuine interests and relevant field-level exposure who can contribute as a nature guides, wildlife conservationists, field research assistant, etc. in and around protected wildlife sanctuary or park or reserve. The Training Location will be Patna, Kaimur, and Bhagalpur.

Note: The online application form is available at http://www.gsdp-envis.gov.in/Index.aspx.

Awareness Campaign

The centre will be conducting quiz competition at school level on the occasion of "world nature conservation day" (28th July). The objective of this program is to spread awareness regarding wetlands, rivers, forest, biodiversity, protected conservation areas, conservation methods and other information to the school kids. The location will be Patna.

Workshop

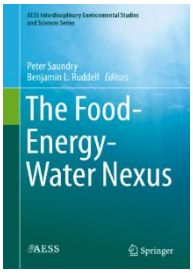
The centre will be conducting a workshop on traditional water management system at school level. The objective of this program is to provide basic knowledge of different indigenous methods of water conservation, irrigation technology like ahar-pynes or other related information to the school kids. The location will be Patna.

Lifestyle for Environment (LIFE)

The Centre will be conducting an event under lifestyle for environment focused on wetlands and other water resources that support life of the community residing around it. The objective of this local event is to sensitize communities residing or depending on ecosystem services from natural water resources which are degrading due to changing lifestyle choices individuals make. It aims to focus on the objectives of SDG goal 12 (Responsible Consumption), 13 (Climate Actions), and 15 (Life on Land).

Important Readings

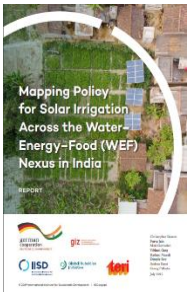
The Food- Energy- Water-Nexus by Peter Saundry, Benjamin L. Ruddell



This book provides a substantive integrated introduction to the food-energy-water nexus suitable for use in higher level undergraduate and graduate level courses and for scholars moving into the field of nexus studies.

Available at https://link.springer.com/book/10.1007/978-3-030-29914-9

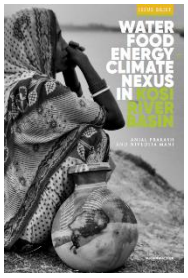
Mapping Policy for Solar Irrigation Across the Water–Energy–Food (WEF) Nexus in India



This paper seeks to assist policy-makers and researchers in India who are working to promote the uptake of off grid, solar-powered pumps for groundwater irrigation ("off-grid solar pumps").

Available at https://www.iisd.org/publications/solar-irrigation-wef-nexus-india

Energy- Climate Nexus in Kosi River Basin



This issue brief focusses on the major challenges faced by the people in the transboundary Kosi River Basin and outlines the nexus between water, food, energy, and climate as major drivers of the recent changes. This issue brief is based on numerous discussions and interactions with the local communities and stakeholders in India and Nepal covering the sample of Kosi river basin.

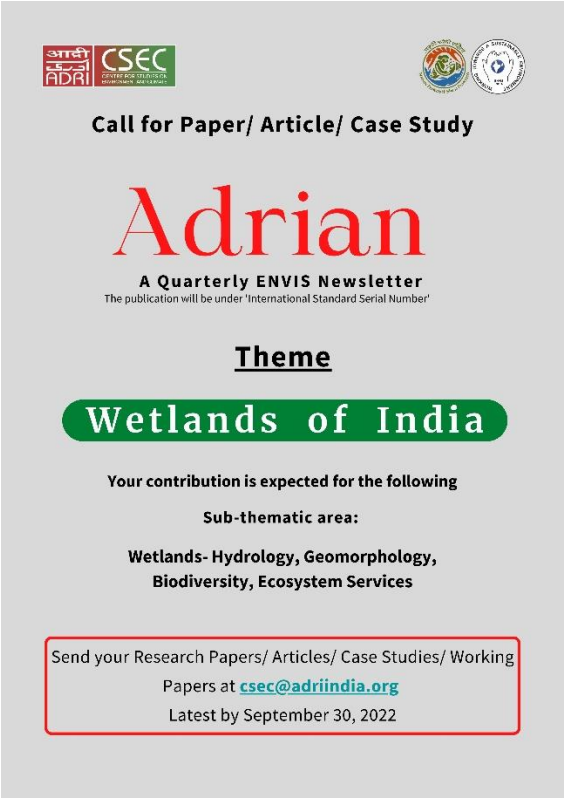
Available at https://www.iisd.org/publications/solar-irrigation-wef-nexus-india

Water Food Energy Nexus: Changing Scenarios in India During Recent Decades

This article presents a comprehensive set of analysis that assess the present status of the water-food-energy nexus in India, along with its changing pattern, in the last few decades. The article finds that, with the growth of population and 15 consequent increase in the food demands, food production has also increased and this has been made possible with the intensification of irrigation. However, during the recent decade (after 1996), the increase in food production has not been sufficient to meet its growing demands precipitating a decline in the per-capita food availability.

Available at https://www.researchgate.net/publication/311467992_Water_Food_Energy_Nexus_Changing_Scenarios_in_India_during_recent_Decades

Upcoming Newsletter



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Address: BSIDC Colony, Off Patliputra Boring Road, Patna-800013

Phone- +91-612-2575649(O) **Web-** www.adriindia.org/centre/csec, **Email-** csec@adriindia.org