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FROM THE PRESIDENT'S DESK

India, with its vast and diverse landscape, is blessed with rich natural resources, including fertile soil and abundant water bodies. However, increasing population pressure, urbanization, deforestation, and climate change have led to significant challenges in soil and water conservation. Ensuring the sustainable management of these critical resources is vital for food security, ecological balance, and long-term environmental health.

Soil and water conservation is undergoing a paradigm shift, moving from simple erosion control to a holistic "landscape-scale" science that integrates climate resilience, carbon sequestration, and advanced technology. The future focuses on rebuilding soil organic matter, with practices like no-till, cover cropping, and agroforestry becoming essential to sequester carbon and improve soil structure. Rather than relying solely on engineered "grey" infrastructure, the future involves using nature-based solutions such as restoring wetlands, reforestation, and using bio-engineering to stabilize slopes which offer multi-functional benefits like water filtration, flood risk reduction, and increased biodiversity. Modern conservation is increasingly data-driven, moving beyond field-scale observations to complex system-wide modeling. Precision agriculture, IoT-based soil moisture sensors, and AI-driven models are being used to optimize water usage, reduce nutrient losses, and tailor conservation measures to specific, local needs. Future efforts will rely on big data and artificial intelligence to create regional plans that link weather models with erosion assessments and soil health outcomes. A new research paradigm focuses on soil architecture (the complex bio-pore network) rather than just soil aggregates to better understand how it governs water and carbon storage.

Effective conservation requires shifting to community-driven, participatory approaches that empower farmers, such as the *Jal Sanchay, Jan Bhagidari* initiative in India, which encourages local ownership of water resources. Future efforts are increasingly linked to economic incentives, such as carbon markets, water quality credits, and "payment for ecosystem services" (PES) schemes. Apart from this, there is an urgent need to educate farmers and stakeholders about modern, sustainable practices, and to address the gap between scientific recommendations and on-the-ground implementation. Future strategies require collaboration between policymakers, researchers, and communities to address the complex, intertwined issues of land, water, and food.

UP State Chapter of SCSI Observed World Soil Day

Chandra Shekhar Azad University of Agriculture & Technology, Kanpur

World Soil Day, celebrated every year on 5th December, aims to raise awareness about the vital role of soils in agriculture, ecosystem services, and food security under the FAO–UN framework. The UP-State Chapter of the Soil Conservation Society of India jointly organized the soil day with the Department of Soil Conservation and Water Management (SCWM) and the Department of Soil Science reflecting the interdisciplinary nature of soil and water issues. About 200 students of Agriculture, Forestry and Horticulture is participated along with Professor and Faculty of the university.

Chief Guest Dr. Raja Ram Tripathi, CEO, Maa Danteshwari Herbal Group, emphasized soil management through green polyhouse systems to enhance per unit farm productivity. Such protected cultivation approaches align with global efforts to improve soil use efficiency, reduce degradation risk, and intensify production sustainably. Dr. Kaushal Kumar, Dean, Forestry, elaborated on the theme of World Soil Day, linking it to the need for sustainable management of soils under increasing pressures from population growth and land-use change. World Soil Day themes typically highlight issues such as soil health, erosion, salinity, and urban expansion, connecting local observances with global priorities.

Dr. Munish Kumar, Professor, SCWM and Secretary, UP Chapter of SCSI, New Delhi, spoke on Soil and Water Management for Sustainable Agriculture in the context of climate change, stressing that patterns of land, water, and energy use strongly influence the global food economy. Global assessments indicate that large fractions of productive land are already degraded and that water erosion is a dominant process, making integrated soil and water management central to sustaining food, feed, fuel, and fibre supplies.

Highlighting the link between Soil Biodiversity and Civilization, Dr. Sarvesh Kumar, Head, SAC, underlined the importance of living soils for maintaining ecosystem functions, resilience, and long-term agricultural productivity. He also proposed the vote of thanks, acknowledging the collective responsibility to adopt holistic soil and water management as an urgent requirement for agricultural sustainability and protection of natural ecosystems and also proposed vote of thanks.

Major Indigenous Agricultural Practices in North East India

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The agriculture of North East India is shaped by its unique geography, which includes fertile plains and vast, mountainous hill regions. This landscape has led to the development of two main types of farming: traditional hill-based methods and modern, settled farming in the plains. Agriculture is the primary source of livelihood for over 70% of the region's population as per NITI Aayog, 2021. However, the region produces only 1.5% of India's total

agricultural output. This highlights a major gap between the region's potential and its current production. About 70 percent of North East India is hilly. In these areas, indigenous tribes practice traditional farming. The most common method is known as *Jhum*, or shifting cultivation. The remaining land consists of fertile plains, such as the Brahmaputra Valley in Assam, where settled agriculture is common.

1. Jhum (Shifting) Cultivation

Jhum, also known as slash-and-burn agriculture, is the most common traditional farming system in the hill areas of North East India. It is a subsistence farming method practiced by hundreds of thousands of families and is a deep part of the local culture and life.

- The Jhum process follows a clear annual cycle:
- In January, farmers select a plot of forest on a hillside and cut down the vegetation.
- The cut trees and plants are left to dry on the slopes for several months.
- Around March or April, the dried biomass is burned. The resulting ash provides a natural, nutrient-rich fertilizer (potash) for the soil.
- After the first rains, farmers plant a wide variety of crops in the ash-covered soil.

The most important feature of Jhum is polyculture, that means many different crops are grown together on the same plot. This can include rice, maize, millets, beans, yams, and various vegetables. This method reduces the risk of crop failure and provides a diverse diet for the family.

Modern Environmental Challenge

The sustainability of *Jhum* depends on a long fallow period. After cultivating a plot for one or two years, farmers would traditionally abandon it and move to a new area. The abandoned plot was left to regrow as a forest for 10 to 20 years, or even longer. This long period allowed the soil to regain its fertility and the forest to regenerate. Today, this system is under severe pressure. Due to a growing population and less available land, the fallow period has been dangerously reduced to just three to six years. This short cycle is not enough time for the soil and forest to recover. It has led to serious environmental problems:

- The soil is quickly depleted of nutrients, leading to "reduced yield".
- Large areas of forest are cut and burned each year without time to regrow.
- Without trees and vegetation to hold it, the topsoil is washed away by the region's heavy rains, "disturbing thereby the ecological balance".
- The continuous clearing of forests destroys wildlife habitats.

As a result, *Jhum* is now "widely disputed as environmentally destructive and economically unfeasible" in its modern form.

2. Sustainable Indigenous Farming Systems

While *Jhum* is the most widespread traditional method, North East India is also home to several other, highly sustainable farming systems. These methods show a deep understanding of local ecology and resource management.

Zabo Farming System (Nagaland)

The *Zabo* system, practiced by the Chakhesang tribe in Nagaland, is a clever, integrated farming model. The word "Zabo" means "impounding of water." The system is built along the slope of a hill and combines four parts:

- The hilltop is kept as a protected forest to capture rainwater.
- Below the forest, ponds are built to collect the rainwater.
- Animal sheds are located above the rice fields.
- At the bottom of the slope, the water from the ponds—mixed with the nutrient-rich runoff from the animal sheds—is used to irrigate terraced rice paddies.

This "perfect example of traditional ecological knowledge" efficiently conserves soil and water, recycles nutrients, and allows for sustainable farming without chemical inputs.

Alder-Based Agroforestry (Nagaland)

This is another "age-old ecological farming practice" from Nagaland, used by several tribes. It involves planting crops along with the Nepalese Alder tree (*Alnus nepalensis*). The Alder tree is special because its roots have a symbiotic relationship with bacteria called *Frankia*. These bacteria "fix atmospheric nitrogen," a process that "enriches soil fertility naturally". This acts as a free, natural fertilizer for the crops. The trees also prevent soil erosion and provide firewood. This system allows farmers to cultivate the same land continuously, making it a "sustainable model of land use" and a direct alternative to Jhum.

Bamboo Drip Irrigation (Meghalaya)

In the hills of Meghalaya, farmers developed a "200-year-old system" of irrigation using only bamboo. It is used on steep, rocky slopes where digging channels is impossible. The system uses a network of bamboo pipes to carry water from natural springs "by gravity flow". The water is transported over hundreds of meters and is engineered so precisely that it is "reduced to 20-80 drops per minute" at the base of the plant. This "highly efficient" system is used to grow high-value crops like betel leaf and black pepper, and it is a masterpiece of local engineering.

Terrace Rice Cultivation

Like in other mountainous parts of the world, many tribes in North East India, such as the Angami of Nagaland, have built complex terraces for "wet rice cultivation." The Apatani tribe in Arunachal Pradesh also uses a highly efficient terrace system that includes raising fish in the same paddies. These terrace systems are a permanent and sustainable form of hill farming.

3. Settled and Commercial Agriculture

In the fertile plains and valleys, farmers practice settled agriculture, which is often more commercially focused. This is where the region's main food and cash crops are grown. Rice is the most important food crop and the staple food of the entire region. It "occupies about 70 percent of the cropped area". In the plains of Assam, farmers grow different varieties of rice—known as Aman, Aus, and Boro—that are harvested in winter, summer, and spring. Along with that the region's different climates also make it a "rich reservoir" for a wide variety of fruits and spices. It is a major producer of pineapples, oranges, especially the Khasi Mandarin, and bananas. The "Tripura Queen Pineapple" is unique and it has been given Geographical Indication (GI) tag. Furthermore, North East India is a national hub for spices like ginger, turmeric, and chillies (such as the GI-tagged "Mizo Chilli"). The region is especially dominant in large cardamom, with Sikkim alone "contributing over 80% to India's total production".

More specifically, the North Eastern part of India is a critical producer of several major industrial crops for the country. Assam is the "number one tea producing state in the country". It produces "over half of the total annual production" of tea in India. Tripura has become the "second largest rubber producer in India," after Kerala. As of March 2024, the state produced an estimated 110,717 metric tonnes of rubber (MyCII). Also, the region holds "65% of India's production value" of bamboo, making it a vital resource for both traditional use and modern industry.

4. Challenges for Development

Despite its rich resources and traditional knowledge, the agricultural sector in North East India faces severe problems that keep it "caught under [a] 'vicious circle of under development'". The main challenges include:

Small Land Holdings: Farm plots are often "small and fragmented," making them "economically unviable" for modern methods.

Low Technology Use: There is "low usage" of modern inputs like high-yield seeds, fertilizers, and machinery, which limits production.

Poor Infrastructure: This is the most significant barrier. The region suffers from "remoteness and isolation" due to poor roads and transportation.

Lack of Storage and Processing: There is a "lack of adequate storage and processing facility" (ResearchGate). This is a critical problem for the region's valuable fruits and vegetables. An estimated "30% of wastage" occurs because farmers cannot store their produce and are "forced to sell at low prices".

Social and Environmental Factors: "Low literacy levels" and a "lack of awareness" about new methods and government schemes prevent progress. The region is also highly vulnerable to "flood, drought, [and] soil erosion".

Conclusion

Agriculture in North East India is a story of two different systems. On one hand, it has a rich heritage of traditional knowledge, seen in sustainable systems like Zabo farming and Alder agroforestry. It also has immense potential, producing high-value crops like tea, rubber, and large cardamom. On the other hand, this potential is held back by major challenges. The most common traditional practice, Jhum, has become environmentally damaging. At the same time, the entire region is "severely constrained" by poor infrastructure, especially a "lack of agro-processing and marketing facility". The future of agriculture in North East India will require a "regionally differentiated strategy". This strategy must blend the wisdom of traditional, sustainable practices with modern technology and, most importantly, critical investment in roads, cold storage, and food processing plants. This is the only way to turn the region's agricultural wealth into true economic prosperity for its people. ■

Vacuum Drum Based Water Pumping System

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A vacuum drum-based water pumping system is a method to move water by creating a vacuum within a drum, which uses the resulting pressure difference to lift water from a source. These systems are often designed to be cost-effective and can operate without electricity, as they use the air pressure generated within the drum, sometimes from water flow and trapped air, to push water through an outlet pipe. A vacuum drum-based water pumping system can be a very cost effective system for lifting and carrying water from a nearby flowing canal/nallah as well as from standing water of farm pond/open well. This is a non-conventional water pumping system that operates as a positive displacement pump and uses vacuum as the pumping medium. Under normal environmental conditions, creation of vacuum requires removal of gases from a given vessel or a chamber with air contained under atmospheric pressure. The system does not require conventional fuel sources for its operation and is self-sustaining for pumping water in standing and flowing water provided conducive working conditions are met with. A 3-D view of the system was created in Auto-CAD with 3000 mm length, 1828 mm width and 1371 mm height, as shown in Fig. 1 and Fig. 2

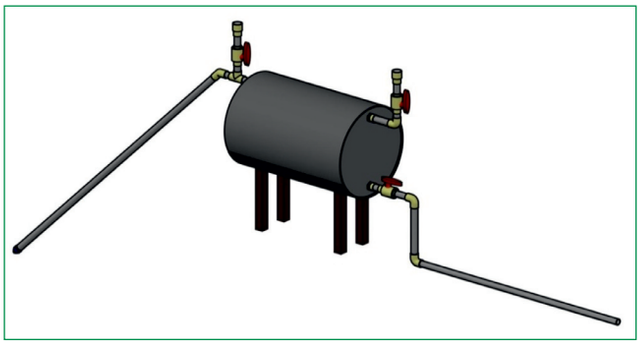

Fig. 1: 3D view of vacuum drum based water pumping system

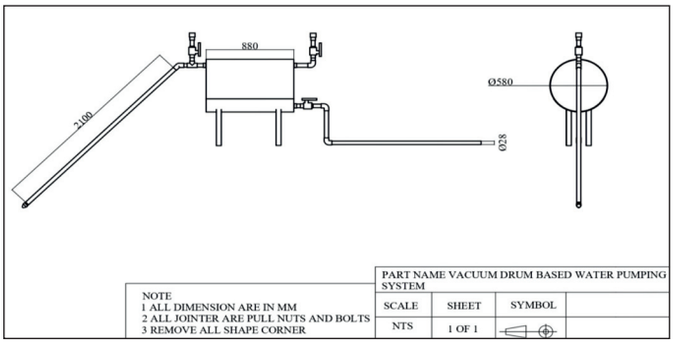

Fig. 2: View of vacuum drum based water pumping system

Major components

MS Drum: A 580 mm diameter, 880 mm length, 200 litre capacity drum of mild steel iron (MS) having the weight of 22 kg is chosen and is fixed on a stand.

Main stand: It is the most essential part of vacuum drum based water pumping system, and provides strength and stability to the overall system body by holding weight of the entire system. It was made of mild steel having overall dimension of 762 mm in length and width of 609 mm.

PVC pipes: 5 m length - 25 mm diameter PVC pipes are used for plumbing. It facilitates ease in installation besides durability.

T-joints and L-joints: 25 mm diameter T and L joints, made of PVC material have been used for interconnecting PVC pipe in the system.

Regulator valve: Three regulator valve of diameter 25 mm has been installed in the system. Out of the 3, one control the outlet of water and the two regulate the pressure within the system.

Solvent cement: Solvent cement is used for proper sealing of all parts of the system. It is in liquid form that has to be applied on the mouth of two interconnecting pipe and then joined. Solvent cement is strong adhesive and dries within few second.

Jointer and Socket: These are used to joint two interconnecting pipe. Special attention has to be given while joining so as to avoid any leakage and break in vacuum leading to failure of the system.

Foot valve: Foot valve is also known as one way valve or check valve that only allow the inlet of water and restrict the back water flow. It is fixed at the bottom end of the suction pipe. It includes the strainer which helps to prevent the foreign material at the time of suction. It also maintains the water in the suction pipe during functioning of the system. The dimension of foot valve is 28 mm diameter.

Working

A 200 litre capacity drum is fixed on a foundation of suitable height. Two holes of 1″ diameter is made with air release valve at 90 degree angle and third hole of 1″ is given at discharge pipe. One regulator is attached with suction pipe, one end of which is connected with foot valve submerged in water body. For operation, drum is filled up with water via air release valve. Water can be filled manually or through other means like priming. Only 80% of the drum capacity is filled with water while the rest 20% space is left out for creating air space inside the drum. Both air release valves are now closed and discharge valve is opened creating a supply of water due to available head. Discharge of water from the drum creates partial vacuum as both the valves are closed. This vacuum reduces pressure inside the drum and water at source (at atmospheric pressure) is pumped up. Discharge from the discharge valve and water pumping to the drum goes on simultaneously. This process goes on as long as the vacuum remains intact. However, in many real situations, the pressure inside the drum may not remain sub atmospheric and increased due to the presence of leaks; consequently the process gets disrupted. The vacuum drum based water pumping system gave a discharge of 2 litres per minute (lpm) to 2.07 lpm at constant suction lift of 1.22 m and distance is varying from 0 m to 12 m. A site with shallow surface water, such a canal, is ideal for the operation of the developed vacuum drum-based water pumping system. ■

World Soil Day Celebration at SCSI-HQ

The Soil Conservation Society of India (SCSI), New Delhi, through its Delhi State Chapter, celebrated World Soil Day (WSD) 2025 on 5thDecember, 2025. The programme was organized in hybrid mode, with members participating physically at the Society Headquarters and virtually through video conferencing. Dr. Anchal Dass, Principal Scientist, Division of Agronomy, ICAR–IARI, New Delhi, and Chairman, Delhi State Chapter of SCSI welcomed Dr. T.B.S. Rajput, President, SCSI, along with members and participants attending both physically and online.

World Soil Day is observed every year on 5thDecember to highlight the vital role of healthy soils in sustaining life on Earth. The observance was first recommended by the International Union of Soil Sciences (IUSS) in 2002, later endorsed by the Food and Agriculture

Organization (FAO), and officially recognized by the United Nations General Assembly in 2013. The first official celebration took place in 2014. The date commemorates the birth anniversary of King Bhumibol Adulyadej of Thailand, a global advocate of soil conservation and sustainable land management. Since then, World Soil Day has become an important global platform for promoting awareness and encouraging actions toward improving soil health and productivity.

On the occasion, Dr. T.B.S. Rajput elaborated on the World Soil Day 2025 theme, "Healthy Soils for Healthy Cities" emphasizing that soil health is not only essential for agriculture but also for environmental sustainability, urban resilience, and human well-being. Although the invited speaker, Dr. S.K. Sharma, ADG (HRM), ICAR, New Delhi, could not attend the programme due to unavoidable circumstances, he shared his presentation titled "Soil Stewardship for a Sustainable and Secure Future – Healthy Soils for Healthy Cities," which was circulated among participants, and also presented by Dr Anchal Dass for the benefit of participants and, through them, society.

The presentation highlighted that soil is the foundation of human civilization and environmental stewardship and is strongly hinges food security, climate resilience, and national security. It noted that nearly 33% of the world's soils are degraded, while in India about 96 million hectares are affected by various forms of land degradation. Soil organic carbon (SOC) in many Indian agro-ecosystems has declined to 0.3–0.6%, far below the desirable threshold, largely due to intensive mono-cropping, excessive tillage, and imbalanced fertilizer use. Rapid urbanization, mining, infrastructure expansion, and changing land-use patterns are further reducing cultivable land, with India losing 1–1.5 million hectares of arable land annually. Soil erosion alone removes about 5.3 billion tonnes of soil every year.

The presentation also stressed the importance of soil biodiversity, noting that soils host trillions of microorganisms essential for nutrient cycling, carbon sequestration, and ecosystem stability, yet nearly 60% of global soil biodiversity is under threat. Declining factor productivity, low nutrient-use efficiency, and poor water-use efficiency were identified as major concerns for future food security. It was emphasized that healthy soils underpin stable food systems, water security, biodiversity conservation, and sustainable rural livelihoods.

Special focus was given to urban soils under the theme "Healthy Soils for Healthy Cities." With rapid urban expansion and projections that nearly 70% of the global population will live in cities by 2050, the ecological health of soils is directly linked to the sustainability of urban ecosystems. Healthy urban soils help regulate temperature, reduce heat-island effects, enhance groundwater recharge, filter pollutants, and support green spaces. However, most urban soils face compaction, contamination, and sealing, increasing flooding risks and environmental health hazards.

The presentation further highlighted scientific advances and policy initiatives, such as the Soil Health Card Scheme, digital soil mapping, precision agriculture tools, natural farming, and carbon farming. It called for urgent action across multiple dimensions of soil security, including biophysical capability, soil condition, economic value, social awareness, and policy support. Key recommendations included promoting regenerative agriculture, protecting peri-urban agricultural lands, incentivizing carbon farming, enhancing SOC, integrating soil stewardship into education, and aligning soil health actions with global climate and sustainability commitments.

The programme concluded with an interactive discussion in which participants shared their views on soil conservation and urban sustainability. The vote of thanks was delivered by Dr. Anchal Dass, who expressed gratitude to the speakers, dignitaries, and participants for making the event meaningful and successful, reaffirming SCSI's commitment to advancing soil health awareness and action. ■

33rd National Conference on "Land and Water Management for Ecological Restoration and Agricultural Sustainability" held at PAU, Ludhiana

Soil Conservation Society of India in cooperation with Punjab Agricultural University, Ludhiana organized 33rd National Conference on "Land and Water Management for Ecological Restoration and Agricultural Sustainability," at Punjab Agricultural University Ludhiana w.e.f. 8-10 December, 2025. The scientists, researchers, academicians, extension professionals, policymakers and stakeholders from 20 states and Union Territories participated in this conference and shared research findings on sustainable approaches and suggested innovative strategies for the long-term management of land and water resources.

The conference was attended by 275 registered delegates. The discussions were held under six themes. The conference successfully addressed critical national priorities related to sustainable land and water

management, ecological restoration, and agricultural sustainability through six well-defined thematic areas.

In the inaugural function, Dr B.R. Kamboj, Vice-Chancellor, Choudhary Charan Singh Haryana Agricultural University, Hisar was the chief guest. The function was presided over by Dr S.S. Gosal, Vice-Chancellor, PAU, Ludhiana and Guest of Honour of the function was Dr. T.B.S. Rajput, President, SCSI, New Delhi. The technical session began with the Prof. J.S. Bali Memorial Lecture by Dr Jagdish Prasad, Former Principal Scientist, Division of Soil Resource Studies, ICAR-NBSSLUP, Nagpur. The session was chaired by Dr. T.B.S. Rajput, President, SCSI and co-chaired by Er. Shamsher Singh and Dr. J.P. Singh.

On the second day of National Conference, a special panel discussion was conducted on the topic Rehabilitation of Flood Affected Soils. The panel discussion was chaired by Dr. Satbir Singh Gosal, Vice-Chancellor. PAU, Ludhiana. Dr. JK Singh and Dr. Ajmer Singh Dhatt were the special guests in the discussion. During this, experts including Dr Manmohanjit Singh, Dr. TBS Rajput, Dr. Rakesh Sarada, Dr. Rajiv Sikka, Dr. JP Sharma and Dr. Arya stressed on restoring the fertility and water-holding capacity of the land as well as advocated the importance of soil testing to check the correct status of soil carbon and nutrients. The experts stressed on working for early warning systems to identify flood-prone areas and urged farmers to adopt soil restoration techniques. On third day of the conference the field visitswere organized to Amritsar, Kandi region of Punjab and to various facilities developed at PAU. ■

Meghalaya Chapter Celebrated World Soil Day

The Meghalaya Chapter of the Soil Conservation Society of India, New Delhi celebrated World Soil Day in collaboration with the College of Agriculture, Kyrdemkulai, Ri-Bhoi district, Meghalaya on 5th December, 2025. The programme was coordinated by Prof. N. Janki Singh, Secretary of the Meghalaya Chapter bringing together faculty members, students and farmers to reflect on this year's global theme: "Healthy Soils for Healthy Cities."

During the session, Prof. Singh highlighted the critical theme, emphasizing that soil health is not just an agricultural concern but a cornerstone of urban sustainability. He urged the students to understand the vital role soil plays in mitigating urban pollution and ensuring food security in expanding cities. The event saw active participation from undergraduate students of both the faculty of agriculture and faculty of natural farming. The research scholars from the School of Natural Resource Management, College of Post Graduate Studies in Agricultural Sciences, Barapani also actively participated in the program. Mr. Aalok Kumar and Ms. Wanika Kharbani actively assisted in successfully conducting the programme. The programme concluded with a unified pledge to adopt and promote sustainable soil practices.

Managing Floods in Punjab Calls for a Critical Review and Fresh Thinking, Focusing on Both Technical Challenges and Policy Matters

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Punjab, India's food bowl has faced recurrent floods that threaten agriculture, infrastructure, and livelihoods. Despite pioneering irrigation and canal systems, the state now struggles with aging infrastructure, silted dams, weak embankments, and fragmented governance. Climate change, erratic rainfall, and poor land-use planning exacerbate risks. This policy paper critically appraises Punjab's flood management challenges and proposes integrated, science-driven, and sustainable policy reforms.

Background

Punjab, located in north-western India, derives its name from the "land of five rivers." Today, only the Sutlej and Beas flow entirely within the state, while the Ravi forms part of its western boundary. The physiography includes the Siwalik Hills, foothill torrents ("choes"), and fertile plains. Rainfall is highly variable, ranging from 300 mm to 1150 mm annually, with 75–80% concentrated in the monsoon months. This hydrological setup, combined with climate variability, makes Punjab highly flood-prone.

Historical Floods

Punjab has suffered devastating floods in 1947, 1955, 1988, 1993, 2008, 2019, 2023, and 2025. These events highlight systemic weaknesses in dam operations, silt management, and contingency planning. The 2025 monsoon inundated 2,000 villages across eight districts, crippling rural economies and exposing governance failures.

Technical Challenges

• **Siltation of Dams and Headworks**: Storage capacities of Ferozepur and Harike headworks have reduced drastically; Bhakra, Pong, and Ranjit Sagar dams have lost nearly 20% capacity. • **Weak Embankments**: Poorly maintained flood defences fail under pressure, leading to flash floods. • **Aging Infrastructure**: Once-renowned canal networks are outdated and fragmented. • **Urban Vulnerability**: New townships lack contingency plans, while traditional flood escape routes have been encroached upon. • **Climate Change**: Short, intense rainfall spells aggravate flash floods compared to evenly distributed monsoon rains.

Policy Gaps

•Absence of a **state policy on environmental flows**. • Outdated water governance and eroding institutional knowledge. • Misalignment between water conservation policies and scientific evidence. •Asymmetry in interstate water-sharing: beneficiary states claim rights but avoid responsibilities for dam upkeep.

Flood Risk Assessment

Modern flood risk assessment using **GIS, remote sensing and multi-criteria decision analysis** (MCDA) is lacking in Punjab. These tools can:

• Map hazard-prone zones using rainfall, soil, slope, and drainage density data. • Identify vulnerable populations and infrastructure. • Integrate hazard and vulnerability layers to produce actionable risk maps. • Support land-use planning, emergency response, and disaster preparedness.

Recommendations

Short-Term Measures

• Continuous desilting of rivers, dams, and headworks. • Annual strengthening of embankments. • Allocation of disaster response funds for preventive flood management. • Real-time data systems, satellite monitoring, and AI-driven forecasting.

Long-Term Measures

• Modernize irrigation and canal networks. • Restore wetlands, tanks, and floodplains as natural buffers. • Ensure environmental flows in rivers. • Establish an expert committee for unbiased dam management reforms. • Promote interstate cooperation for shared responsibility in dam upkeep. •Integrate flood management into urban planning.

National Significance

Punjab contributes over 35% of India's wheat and 25% of rice to the central pool. Floods in Punjab are not merely a state-level issue but a **national challenge** with implications for food security, grain prices, and farmer confidence. The Government of India must step in with both immediate relief and long-term modernization strategies.

Conclusion

Floods in Punjab cannot be eliminated, but their impact can be minimized through foresight, science, and accountability. Integrated water management, modern technology, and stakeholder collaboration are essential to safeguard Punjab's agricultural economy and national food security.

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