Drought, Flood and Climate Change
Global challenge, local solution

Water conservation for mitigation, adaptation, and resilience

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Community Driven Nature Rejuvenation

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Nurturing a fragile ecosystem

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Prologue: A first - Water in COP 27

It took 27 COPs to bring water – for the first time – into the official COP declaration. The draft declaration from the recently concluded COP 27 held in November 2022 at Sharm-el-Sheikh, Egypt recognises the importance of water.

Water has been a theme for events in earlier COPs, but despite being vital for human rights and climate justice; climate mitigation, adaptation and developing resilience; for reducing forced migration, conflict and inequality; and providing food and livelihood security and health benefits, water never found a mention in official COP declarations.

The COP 27 was historic in that water was mentioned in the official COP 27 declaration

Draft COP 27 declaration

Excerpts from the draft COP 27 declaration that mentions water,

Recognizing also the critical role of protecting, conserving and restoring **water and water-related ecosystems** in delivering benefits for climate adaptation and its co-benefits, while ensuring social and environmental safeguards,

79. Recalls also the IPCC findings that GHG emissions reductions and removals from forests and land use are essential to all pathways to global net zero and the critical role that healthy forests serve in climate regulation, biodiversity protection, food and **water security**, soil fertility and limiting forced migration;

81. Emphasizes the importance of protecting, conserving and restoring water and water- related ecosystems, including river basins, aquifers and lakes and *urges* Parties to further integrate water into adaptation efforts[i].

Speaking at a Press Conference organised on Nov 7, 2022 at the COP, Stockholm water awarded issued a worldwide appeal to address for drought and flood mitigation – both disasters which have increased due to climate change through community driven water conservation. He assured that the People's World Commission on Drought and Flood is an action group, focused on generating evidence and positive action.

Dr Rajendra Singh addressing a Press Conference at UNFCCC on Nov 7 (L) and release of the book River Rejuvenation for climate resilience, livelihood and dignity during an indigenous peoples' meet (R) during COP 27

Most climate change disasters are water related. Developing resilience and mitigating these disasters also rests with water

Most climate change-related disasters are water-related. All continents are experiencing drought and flood, some of which are for the first time or on an 'unprecedented scale.'

The solution to resilience against these drought and flood disasters also lies in water. With robust water systems, it is possible to scale down the area, intensity, and frequency of disasters. Some disasters can even be prevented.

Reducing emissions is non-negotiable. But this is not enough. As the UNFCCC continues to grapple with reducing emissions, the earth is heating up and in dire need of healing. **This healing is not possible without water security.** Climate change mitigation, adaptation and resilience is not possible without water.

Solutions to global problems of climate change are local, through community driven nature rejuvenation which restores ecosystems and dignity and enables peace and security. This has been proven by sustainable and time-tested examples in India wherein groundwater was recharged, and rivers revived. Replete aquifers and flowing rivers provide cushioning against climate shocks, help regulate climate and sequester carbon.

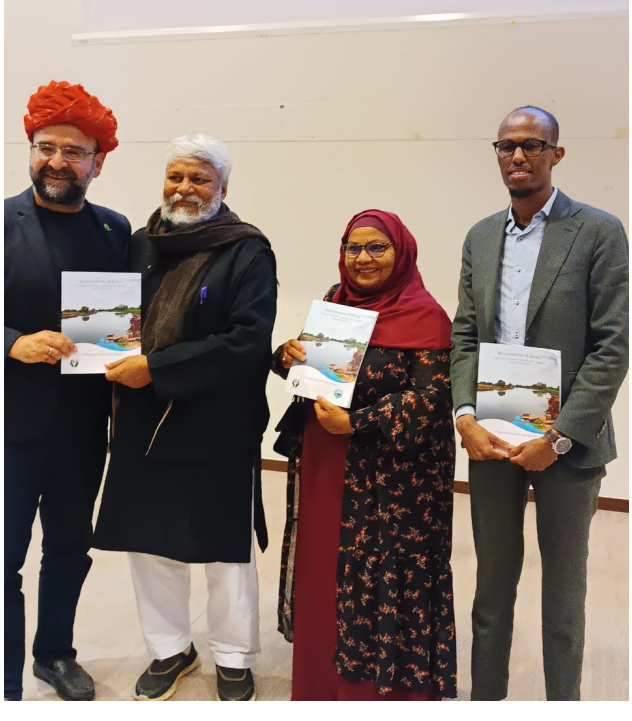
There is a need to amplify this kind of work. The United Nations, World Bank, other multilateral agencies, donors, governments, academia, civil society and other stakeholders need to strengthen their focus on decentralised approaches for such ecologically appropriate climate action, through their policies, programs and investments. Subsequent COPs must acknowledge, include, and strengthen commitments for community efforts in water conservation, which leads to recharged groundwater resources and revival of rivers, which then set in motion a series of restoration and revival processes and over time, resilience.

To lead this positive action, an independent **People's World Commission on Drought and Flood (PWCDF)** under the Chairmanship of Dr Rajendra Singh, with Secretariat at the International Association for Advanced

Materials (IAAM), in Urlika, Sweden was formed during the Stockholm World Water Week in September 2022. This Commission was a logical follow up of atmosphere building that had led to serious concern about flood and drought, more so after the serious drought that had affected Europe.

Book release 'River rejuvenation for climate resilience, livelihood and dignity: Living example was released by then Swedish Minister for Health, Social Affairs and Climate and Environment, Ms Annika Strandhall during World Water Week (Above). The book was also shared extensively with people from across the world (Below) and in India

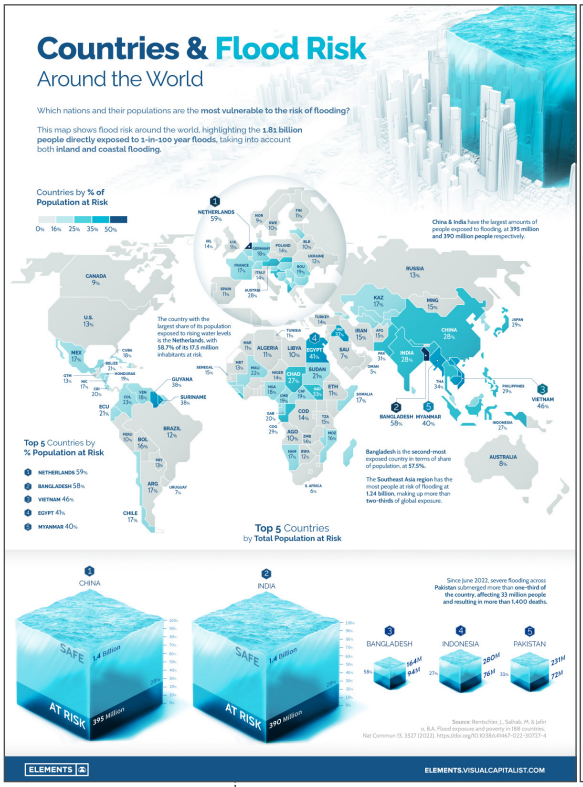
Several discussions on climate and the water crisis were held during Stockholm World Water Week

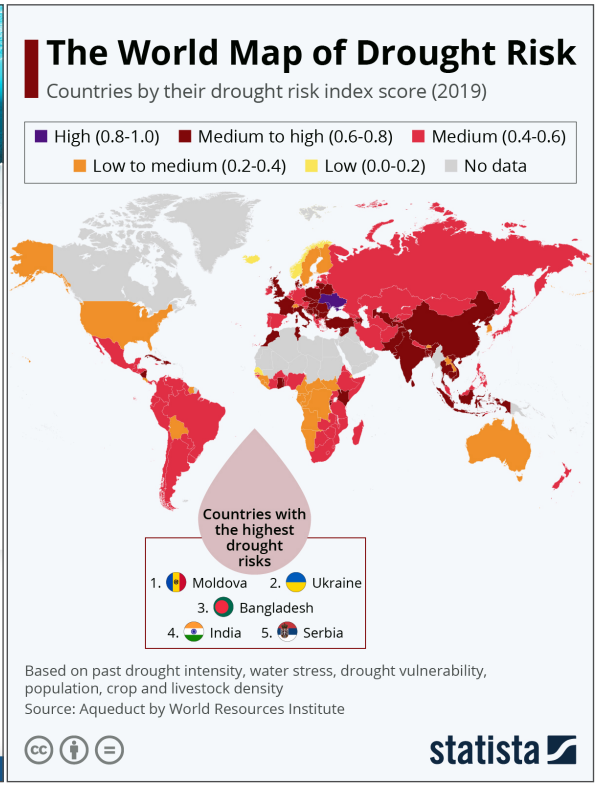


The People's World Commission on Drought and Flood was formed as an action group and a follow up of the serious concern and need to find community-centric solutions for drought and flood mitigation and resilience

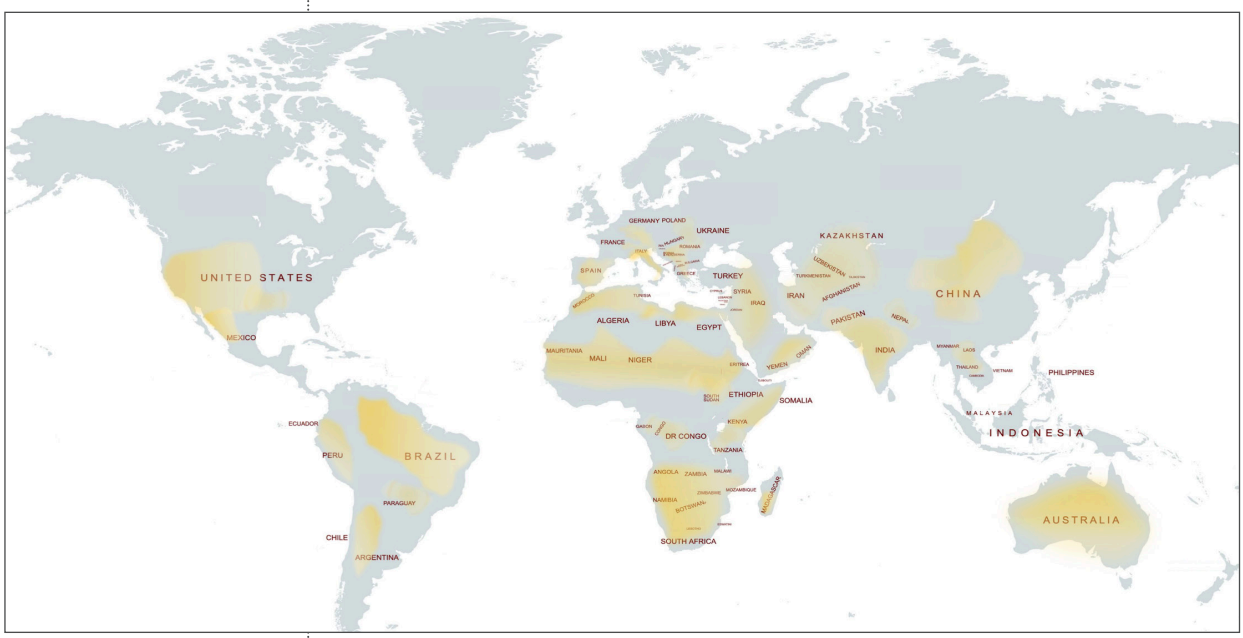
The PWCDF serves as a platform to bring different stakeholders together for reducing risks to lives, livelihoods and ecosystems and building resilience through community driven nature rejuvenation by generating awareness, undertaking research, creating a knowledge repository, and most importantly, facilitating ecologically and financially sound and culturally and equitable appropriate action.

Constitution of the Commission at KTH, Sweden





These maps indicate the risks, scale and spread of floods[1] and drought[2] and the countries most affected by drought between 2020-2022[3]



[1] Countries & flood risk around the world

[2] World map of drought riskhttps://cdn.statcdn.com/Infographic/images/normal/25101.jpeg

[3] World map of drought risk and countries affected by drought in 2020-2022
https://wwwuncd.int/sites/default/files/2022-05/Drought%20in%20Numbers.pdf

I. Extreme weather events and climate change: Contribution and attribution

Droughts are among the greatest threats to sustainable development, especially in developing countries, and increasingly in developed nations too. The number and duration of droughts has increased by 29 percent since 2000, as compared to the two previous decades. When more than 2.3 billion people already face water stress, this is a huge problem. No country appears immune to drought[ii].

The year 2022 has been one of climate shocks: As people and economies across the world are struggling to recover from COVID-19, high intensity cyclones, hurricanes and storms, unprecedented high temperatures, dumping of rain and drought are hitting populations across the world. Perhaps the most unexpected was the drought in Europe. Rivers dried up and buried history emerged. No continent has remained unaffected.

Severe drought affects Africa more than any other continent: In the last 100 years, more than 200 drought events were recorded, accounting for 44 per cent of the global total. Over the past century, the highest total number of humans affected by drought were in Asia.

More than 1.8 billion people living worldwide are at risk of severe floods: Most reside in low- and middle-income countries in Asia, and four out of 10 live in poverty [iii].

Since 2020, heat waves, drought, and floods have battered the world, some of which have been ascribed to climate change. For example,

- In summer of 2022, drought across large parts of Europe, the US and China was made **20 times more likely** by climate change due to high temperatures. Rivers dried up, water shortages increased, soils dried up due to deficits in soil moisture and there were extensive fires. Compiling all the evidence together, scientists found that human induced climate change increased the 2022 root zone soil moisture drought. Their models showed that soil moisture drought will continue to increase with additional global warming [iv].
- Researchers from World Weather Attribution say that this type of drought would only happen once in 400 years, if not for human-caused climate change. They now expect this to happen every 30 years, given the extent of climate warming [v].
- In July 2022, the Italian government declared a state of emergency in five regions because of a drought caused by lack of rain and rising temperatures. For the Po river basin, this was the biggest crisis in the last 70 years[vi].
- Droughts, floods extreme weather events are increasing in intensity from Madagascar in Africa to Iran in Middle East, to Asia and South America's Pentanal, the world's largest tropical wetland. In the first half of 2021 itself, drought was prevalent in most continents[vii].

Non-refutable evidence points towards an increase in drought and flood due to climate change

Drought and flood disasters have increased in intensity, area and frequency across continents, and on scales which meteorologists are not able to forecast

- In 2020, the number of people affected worldwide due to drought was nearly 19 million [viii].
- The floods in Pakistan in 2022 affected more than 30 million people [ix].
- The deadly floods that swept across western Germany and parts of Belgium in 2021 shocked scientists. Within 24 hours, 15 cm of rainfall was dumped, swelling streams which then washed away houses and cars and triggered landslides. Then Prime Minister Angela Markel stated, "The German language can barely describe the devastation." It was then that the scientists realized that they needed to focus on smaller streams, and not only large rivers [x].
- Looking at extreme rainfall this year, climate change
    - Likely increased extreme monsoon rainfall that led to flooding of highly vulnerable communities in Pakistan.
    - Increased heavy rainfall in Eastern Northeast Brazil.
    - Climate change-exacerbated rainfall caused devastating flooding in Eastern South Africa.
    - Increased rainfall associated with tropical cyclones hitting highly vulnerable communities in Madagascar, Mozambique, and Malawi [xi].
    - High temperatures exacerbated by climate change made 2022 Northern Hemisphere droughts more likely [xii].
    - In 2022, Climate change likely increased extreme monsoon rainfall, flooding highly vulnerable communities in Pakistan[xiii].
    - In 2022, the high temperatures experienced by UK of July were highly unlikely without human caused climate change[xiv].
    - The massive flooding drowning Nigeria displaced 1.4 million people and killed hundreds.
    - The Netherlands, a country long shaped by its overabundance of water, is suddenly confronting drought.
    - The Mississippi River, known for its vast reach and powerful currents, has withered to levels not seen in decades, choking shipping lanes and endangering drinking water supplies[xv].
    - Up to October 2022, large parts of West Africa experienced large-scale flooding caused by above average seasonal rainfall and water management practices. The above average rainfall, coupled with the release of several dams was cited as causes behind the devastation. The above average rainfall throughout the rainy season and shorter spikes of very heavy rain led to flash floods and riverine floods. These devastating impacts were further exacerbated by the proximity of human settlements, infrastructure, and agricultural land to flood plains, underlying vulnerabilities driven by high poverty rates and socioeconomic

factors, and ongoing political and economic instability.

- Food crisis in Central Sahel in 2022 driven by chronic vulnerability with uncertain role of climate change[xvi]. This food shortage occurred after an erratic rainy season in 2021 which affected crop production and reduced food stocks several months later.

India and extreme weather events

India recorded extreme weather events on 241 of the 273 days from January 1 to September 30, 2022. This means that close to 90 per cent of the first nine months of this year, India had an extreme weather event breaking in one or more parts of the country. These extreme weather events included heat and cold waves, cyclones, lightning to heavy rain, floods and landslides. India experienced record-breaking temperatures for several months and regions across the country were deluged because of very and extremely heavy rainfall. This led to floods and the loss of life and livestock. This speaks of the increased frequency and intensity of the extreme events[xvii].

These disasters have claimed 2,755 lives, affected 1.8 million hectares (ha) of crop area, destroyed over 416,667 houses and killed close to 70,000 livestock. This estimation of loss and damage is probably an underestimate as data for each event is not collated, nor are the losses of public property or crop loss calculated.

The 2022 heatwave is estimated to have led to at least 90 deaths across India and Pakistan, and to have triggered an extreme Glacial Lake Outburst Flood in northern Pakistan and forest fires in India. The heat reduced India's wheat crop yields, causing the government to reverse an earlier plan to supplement the global wheat supply that has been impacted by the war in Ukraine.

Up to September 2022, India experienced an extreme weather event in nearly 90 per cent of the days

Romit Sen

India is amongst the top five countries with the highest drought risk

II. Understanding drought and flood

Drought and floods have increased because of the tampering with natural water systems. As a result, the buffering capacities of natural ecosystems is lost

Drought and flood have increased because of environmental destruction AND climate change. The rain that used to nurture and regenerate soil now erodes it, causing both, drought and flood.

Increased droughts and floods are results of a nature-destructive, unequal and unsustainable growth model which has led to increasing temperatures on one hand, and a degradation of ecosystems which are natural carbon sinks on the other.

The areas affected, the number of occurrences, and the severity of droughts and floods have all grown significantly over the course of the last few decades. These extreme weather events have been attributed to a variety of causes: Natural phenomena, deforestation, disruptions in river flows and drainage, drying up of life-saving rivers, encroachment of riverbeds and other surface water bodies, excessive extraction of groundwater, and most recently, climate change. **Natural ecosystems that protected against catastrophic weather events and provided a buffer against their effects are being destroyed.**

As nature destruction continues greenery is lost. The regeneration of the soil stops due to decrease of grass cover and greenery that acted as sponge, slowing the flow of rain, arresting it and recharging groundwater. Now, the rain that falls on the bald surface of the earth takes the soil with it, blocking causing siltation in rivers, and the riverbed rises, reducing water holding capacity of the river. Blocking, encroachment of water channels, ponds and other surface water bodies results in poor drainage and speedy flow of water, causing soil erosion. This causes flooding as water enters and continues to remain in villages and cities. When intense rain falls within a short period of time, then chances of both, drought and flood increase. It is well known fact that climate change is affecting the monsoon cycle in terms of duration, timing and volume of rain.

Encroachment on riverbed affects flow of river. Water holding capacities are lost, leading to drought and flood

Earlier, rainwater increased soil moisture. Now, the rainfall causes soil erosion instead of increasing soil moisture and recharging groundwater. The rain runoff is rapid and this rapid flow creates drought-like conditions. As the water collects downstream, it causes flood. Thus, there is rapid rotation of drought and flood.

Megadroughts

In south-western North America and the Pacific coast of South America, worst-in-a-millennium megadroughts have created a slow-moving disaster, as reservoir levels decline and whole regions prepare to make unprecedented cuts to make up the shortfall[xviii]. The megadrought in south-western North America is the worst in more than 1,000 years[xix].

While patterns of drought and deluge are common throughout history, human-driven climate change is disrupting these cycles, making it more difficult to predict exactly how the current megadrought in south-western North America will end. Human-caused climate change is making droughts more severe – and could shift some regions of North America into permanent drought conditions[xx].

Exceptionally severe and persistent droughts – or megadroughts – have wreaked havoc on human societies for thousands of years[xxi]. A megadrought in northern China between AD 1627 and 1643, for instance, caused a famine that killed an estimated 20 million people and may have sparked a revolt that toppled the Ming Dynasty.

The severe drought in California is attributed to its overdraft of groundwater and climate change

Droughts and floods lead to displacement and forced migration: The poor, the disadvantaged, women, children, and youth are being forced to move away from their roots and relocate to urban areas and other countries to survive. Education, health and the social fabric is disrupted. Livelihoods are lost. Poverty and inequality deepen.

Is over pumping also a cause for California forest and severe drought?

For more than a century, farmers have pumped more groundwater than was replaced. California has lost more groundwater than held in all its reservoirs[xxii].

Pumping water from aquifers in California's Central Valley has caused the land to sink, permanently reducing the water storage capacity. California's Central Valley has lost roughly 85 cubic kilometres of groundwater storage since 2004 due to intensive pumping during periods of drought.

The Central Valley is one of the most productive agricultural regions in the world, growing 40 per cent of the fruit and nuts produced in the US. When surface water is inadequate to irrigate all those crops, farmers pump groundwater from the region's aquifer.

Economic losses due to flood and drought are colossal. Heatflation is now an accepted word

III. Economic loss due to climate change, drought and flood

The global economy could lose 10 per cent of its total economic value by 2050 due to climate change[xxiii]. Global warming is now acknowledged as a factor that leads to inflation, called heatflation[xxiv].

It's clear now that the current economic development model has led to climate change. This economic model now threatens economic gain and growth itself. Along the way it has led to deepening inequality, food insecurity, perpetuating poverty and disease resulting in livelihood risks and unrest.

- Around the world, at least half of the 59 million internal migrants in 2021 were displaced by the effects of climate change, according to the United Nations. This is loss and damage — irreversible climate-related devastation that cannot be mitigated or adapted to. Dealing with it is pushing developing countries into ever-greater debt and their economies to the brink of collapse. The African Development Bank reported in September 2022 that the continent is losing between 5 per cent and 15 per cent of its growth in gross domestic product per capita each year because of climate change.
- Between 1980 and 2020, climate-related extremes caused economic losses totalling an estimated EUR 487 billion in the EU-27 Member States. Although analysing trends in economic losses is difficult, partly because of high variability from year to year, climate-related extremes are becoming more common and, without mitigating action, could result in even greater losses in the coming years. The EU adaptation strategy aims to build resilience and ensure that Europe is well prepared to manage the risks and adapt to the impacts of climate change, thus minimising economic losses and other harm[xxv].
- The economic impact of climate-related extremes varies considerably across countries. In absolute terms, the highest economic losses in the period 1980-2020 were registered in Germany followed by France

Dried rivers in Europe tell a story of high temperatures and failed rains

Drought led to water shortages in Italy and to the declaration of an emergency in five regions

then Italy. The highest losses per capita were recorded in Switzerland, Slovenia and France, and the highest losses per area were in Switzerland, Germany and Italy[xxvi]

- Extreme and untimely weather events are affecting food production and hence food security and prices. European countries are now facing heatflation, as yields decline. Fears of a potential global food security crisis are growing as European farmers struggle to save their crops from extreme weather events. According to an EU bulletin, published in October 2022, yields of crops such as soybean, sunflower, and maize were 9% below average. A lack of spring rainfall, combined with drought and freak storms, have spoiled crops in Italy, France, and Spain, with many farmers and agricultural associations warning that this year's continental crop yields will be significantly smaller than usual.

In Italy

- Water shortages and drought have led to a drop of as much as 45 per cent in corn and animal feed yields, and a 30 per cent reduction in wheat and rice production.
- The drought has also affected the country's fruit and milk production, which is down between 15 per cent and 20 per cent because of heat stress, leading the Italian government to declare a state of emergency in five regions this July.
- According to President Mario Draghi, a lack of rainfall, together with rising temperatures, has severely affected two of Italy's main rivers, the Po and the Tiber, which have virtually dried up, leading to the worst drought the country has faced in 70 years. The Po River and surrounding drainage basins are particularly significant for the Italian agricultural industry since more than half the country's national pork and beef livestock are reared here[xxvii].
- **In France**, a combination of unusual summer heat levels, together with freak hailstorms, strong winds and torrential rain, have affected fruit, cereal, and wine production in departments across the country. French dairy farmers warn of a coming milk shortage this winter due to animal fodder shortages and parched grazing areas. In some places, levels are so low that drinking water is having to be brought in by truck[xxviii].
- **Spain's** olive oil sector, which is responsible for supplying almost half of the world's total olive oil exports, has especially affected: Spain's olive harvest is expected to be a quarter of the average produced in the last five years[xxix].

Economic impacts: India

According to a 2018 report of the World Bank – South Asia's Hotspots: The impact of temperature and precipitation changes on living standards:

'Rising temperatures and erratic rainfall patterns could cost India 2.8 per cent of its GDP. According to a World Bank estimate, climate change impacts are likely to lower the living standards of nearly half of India's population (approximately 600 million people) by 2050.

In India today, approximately 600 million people live in locations that could either become moderate or severe hotspots by 2050 under a business-as-usual scenario, the report says. States in the central, northern and north-western parts of India emerge as most vulnerable to changes in average temperature and precipitation.

According to the report's analysis, by 2050 **Chhattisgarh and Madhya Pradesh** are predicted to be the top two climate hotspot states and are likely to experience a decline of more than 9 percent in their living standards, followed by Rajasthan, Uttar Pradesh, and Maharashtra. **Seven out of the top 10 most-affected hotspot districts will belong to the Vidarbha region of Maharashtra** [xxx].

The Indian economy also stands to be affected due to climate change with extreme weather events directly affecting agriculture

A Government of India estimate indicates that extreme temperature shocks reduce average farmer incomes by 4.3 per cent and 4.1 per cent during kharif and rabi seasons, respectively, while extreme rainfall shocks reduce average incomes by 13.7 per cent and 5.5 per cent. The main channels through which climate change would impact farm incomes would be an increase in average temperatures, a decline in average rainfall, and an increase in the number of dry days. All three are likely to be correlated, and therefore the total impact of climate change will not be the simple sum of these individual effects[xxxi]

Drought leads to crop failure and unexpected pest attack of cotton in Maharashtra

IV. Climate change and health

Climate change will result in heavy health, economic and social burden. Diseases will expand to new areas and new diseases will emerge, straining existing health infrastructure and fragile economies and livelihoods. The threat of new infections looms large.

- Health impacts of drought can be inter-generational. Drought restricts access to nutritious food and clean water, increasing susceptibility to malnutrition and disease. Available data indicates that the short-term effects of drought on human health include those caused by water shortages and concomitant food shortages and by contaminated water. Dehydration caused by insufficient liquid intake, and diarrhoea are major causes of infant mortality. In pregnant women, inadequate intake of calories and micronutrient malnutrition, resulting from food and mineral shortages, compromise maternal health and foetus development. Malnutrition in turn compromises the immune system, increasing susceptibility to infection.
- The potential long-term effects of malnutrition in utero and early childhood include stunting and metabolic diseases such as diabetes and hypertension have been observed during drought[xxxii].
- Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.
- Between 2030 and 2050, climate change is expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress.
- The direct damage costs to health (i.e excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between USD 2-4 billion/year by 2030.
- Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.
- Health impacts of floods include death, injuries, diarrhoeal, vector and rodent borne disease, snake bites, respiratory, skin and eye infections, and epidemics. Floods also cause mental stress and affect hygiene practises of women.

Climate change will impose a heavy health burden. Drought and flood can have intergenerational Health impact

“Migration and displacement have deep and long lasting impacts on physical and mental health, and well-being, and cultural and linguistic differences, financial barriers, stigma and discrimination can all hamper access to health services for refugees and migrants,” – Dr Tedros Ghebreyesus, WHO Director General.

The threat of new zoonotic disease and pandemics due to climate change is real

Emergence of new disease

Seven viruses from the Siberian permafrost have been revived and replicated themselves in the lab – including the oldest revived so far[xxxiii].

The likelihood of an extreme infectious disease epidemic – similar to the COVID-19 pandemic – could triple in the coming decades, according to a recent study published in the *Proceedings of the National Academy of Sciences*[xxxiv].

Climate change can both facilitate zoonotic spillovers and influence transmission chains[xxxv]. Zoonotic spillover is the multilevel process by which pathogens (e.g., SARS-CoV-2, Ebola virus, human immunodeficiency virus and avian influenza viruses) manage to overcome a series of natural barrier and infect other animal species.

Climate can directly facilitate a pathogen's survival, development and dissemination and thus ease spillover. On the indirect side, instead, the effects of climate are much wider and far more complex. Climate change, superimposed onto a dramatic anthropogenic alteration of ecosystems, is leading to a gradual substitution of species, shrinking of ecosystems and decrease in species diversity. These trend-like changes can clearly lead to spillovers in different ways and to closer and more-general encounters between wildlife and humans. However, climate extremes, acting on a much shorter timescale, can also directly or indirectly affect the frequency and intensity of forest fires, droughts, floods, famines, and migrations, equally acting as point stressors and exerting intense zoonotic pressure. An example might be epidemics of yellow fever virus in non-human primates in the Brazilian Atlantic Forest that began in 2016. There, the howler monkeys (Alouatta species) are highly susceptible to infection with yellow fever virus, and epizootic diseases driven by climatic anomalies often precede human cases, in epidemics that mirror zoonotic waves. Climate should be seen mainly as a necessary but not sufficient factor that contributes to disease emergence, enhances the ability of viruses to infect us more easily.

Zoonotic diseases now account for 60% of all diseases and 75% of emerging diseases, according to the CDC[xxxvi]. Animals are often reservoirs of contagious bacteria and viruses. That means they carry bacteria or a virus, which can mutate and evolve, and humans may become infected through direct contact or indirectly through soil, water, or surfaces.

As Earth's climate continues to warm, researchers predict that wild animals will be forced to relocate their habitats – likely to regions with large human populations – dramatically increasing the risk of a viral jump to humans that could lead to the next pandemic. This research shows that animal movements and interactions due to a warming climate might increase the number of viruses jumping between species[xxxvii].

Focusing on carbon emission is non-negotiable. So is the focus on nature rejuvenation, for which water is key

V. Why only focussing on carbon emissions in not enough

Solutions to address climate change, largely focus on decarbonization and the use of renewable energy sources. However, even if there is a 100 per cent switch to clean energy, this will not be enough to mitigate, adapt and develop resilience against climate change.

It was against this background that the book **River rejuvenation: Climate resilience, livelihoods dignity: Living examples** was released during the World Water Week, held in Stockholm, Sweden in September 2022[xxxviii]. The correlation of climate change with increased occurrences of drought and flood were raised by participants in several sessions and concern expressed on the impact of these disasters on ecosystems, food insecurity, livelihoods, migration, rising inequality, loss and damage to economies, health, education, gender, children, peace, and security. At the same time, the role of water in climate change mitigation, adaptation and developing resilience was also discussed.

The book was released on various platforms and with different groups, **highlighting the importance of water for climate change mitigation, adaptation and building resilience.** This book describes living examples of rainwater conservation which led to river rejuvenation, which in turn had led to rejuvenation of the ecology and livelihoods in the short term and mitigation and resilience in the long term.

Droughts and floods are global problems, but with local community-driven solutions. Where communities work to get rid of the drought, the area becomes drought resilient. Floods can be avoided, or their impacts reduced. In the long term, climate change mitigation can be achieved.

Conservation, restoration, and improved land management actions increase carbon storage or avoid greenhouse gas emissions in landscapes and wetlands across the globe. Combined with innovations in clean energy and other efforts to decarbonize the world's economies, these natural climate solutions offer some of our best options in the response to climate change. **For this to happen, the key element is water. Water is key for climate change mitigation, adaptation, and resilience.**

VI. How resilience can be achieved: By slowing the flow of rain

Slowing the flow of rain and directing it into the groundwater aquifers and surface water bodies provides cushioning against drought and flood. It makes resilience possible.

Rapid rain runoff erodes. It erodes the fertile soil and carries it to surface waterbodies and rivers and causes siltation of riverbeds and ponds, tanks, and lakes. This reduces the water holding capacity, which in turn causes overflow and flooding. Coupled with intense rain spells, which have increased with climate change, drought and flood disasters increase.

Spells of drought and flood make soil fragile. In California, after the intense heat wave and drought, the rainfall was heavy. The soils were in no position to hold the moisture, and as a result the rain simply flowed away, without groundwater recharge.

The running water (rapid runoff) must be made to walk, the walking water should be made to crawl, and the crawling water should be diverted into ponds and groundwater aquifers, filling the emptying belly of the earth. This is possible by protecting forests, regenerating degraded forests, and increasing the area under forests and tree cover. Increasing greenery through grasslands also helps. Rivers must be rejuvenated.

It is possible to achieve resilience against drought and flood by slowing the flow of rain

Recharge of groundwater aquifers is possible through various measures that consider the local ecology, rainfall, and terrain. Traditional water conservation measures have existed in different parts of the world. In India, depending on the ecology, different water harvesting systems existed that captured the rain which was used for recharge or for direct use. Other Asian countries such as Bangladesh, Nepal, Pakistan, and Sri Lanka also have traditional water conservation methods. In Africa also, traditional wisdom is replete with natural ways of capturing every raindrop that falls, for example by making recharge pits and other structures to slow and capture the flow. Developed countries such as Singapore, Japan, Germany, New Zealand, and others also capture rain [xxxix]. Efforts are on to capture flood runoff in California, US.

Water for nature rejuvenation

Two main streams of action can provide solutions: Taking cue from the local ecology and working towards water security. Climate resilience will depend on how we respect and act on both.

The experiences of Tarun Bharat Sangh (TBS), some of which are more than four decades old, form the basis of the above premise. This experience proved to us how decentralized, community-driven water conservation leads to climate change adaptation and resilience. This work has led to nature regeneration through groundwater recharge, river rejuvenation, increase in forests and biodiversity, livelihood security, socioeconomic change, increase in rainfall, and a reduction in temperatures. It has also led to climate mitigation[xl].

It is with this experience that work began in new areas in Rajasthan and Maharashtra. Using indigenous knowledge and community-centred water conservation methods, and with an understanding of the local ecology and geology it has been possible to increase groundwater resources and revive rivers in districts of Rajasthan and drought-prone Sangli district of Maharashtra. The example of Sherni river shows us that this is possible even in rocky areas hilly areas, by involvement and participation of marginalised communities, some of whom were engaged in a life of crime for survival. If community-centred, decentralised water conservation is possible under such circumstances, it is possible anywhere. The example of Agrani river demonstrates how it is possible to work towards revival of a transboundary river (shared between states of Maharashtra and Karnataka) in the spirit of cooperation and learning.

Both the examples show the ripple effects of water conservation. Capturing the rain for groundwater recharge led to augmentation of groundwater resources and rejuvenation of rivers. It led to revival of forests and land, boost in agricultural income, animal husbandry, fisheries, increase in gene pool, and decline in distress migration.

The lessons learnt which can be used for framing policy and influencing action include the following:

1. *Clouds store sufficient water*

Rivers must be rejuvenated for the cushioning effect they provide against drought and flood

Monsoons fail when clouds sail away. Water conservation results in an increase in greenery. As agriculture increases and forests regenerate, evapo-transpiration increases, and the environmental processes thus put in place attract these clouds and rain falls on parched lands. Forests attract the rain.

2. *Rivers provide cushioning effect against climate change*

Healthy and flowing rivers are critical for climate resilience. Rivers cushion against extreme weather events. Rivers can be brought back from their ill-health by focusing on the various streams that contribute to its flow. For rivers to be healthy, these small streams and rivulets must be rejuvenated. The land of a river and its flood plains must be protected. The rivers need to be protected against encroachment and overextraction. The rainfall needs to be harvested for groundwater recharge. Healthy river flows contribute to groundwater recharge and the reverse is also true. The symbiotic relationship between groundwater and surface water must be maintained for climate cushioning.

3. *Interventions must centre on the local ecology*

Suitability of the location of the structure depends on an understanding of the local ecology, topography, geology, and rainfall pattern. India's ancient water conservation wisdom is based on this knowledge. Local water security leads to immediate boost in income and revival of nature, and thus begins the nature regeneration process.

Successful water conservation efforts are those which are community centred and ecology-driven

4. Recognise the power of small interventions for water conservation

Small/ micro water conservation structures are powerful. They lead to immediate benefits in surrounding areas and if constructed over a large area, lead to macro nature rejuvenation and livelihood benefits, without displacement or destructi6on. Over time, with judicious use of water these structures contribute to river flows and to cushioning against extreme weather events.

5. *Water conservation leads to healthy and biodiverse forests which in turn regulate the water cycle*

Forests attract rain and regulate temperatures. Forests slow runoff and protect against soil erosion. Forests help recharge groundwater. A healthy ecosystem that is rich in biodiversity offers protection against climate change shocks.

When groundwater aquifers are filled, and streams flow, soil is hydrated and the earth springs up different plants and trees. The gene pool increases, birds and animals visit to quench their thirst. Wildlife gets a big boost, there is an increase in species and populations. With water being available at different points in the forest, as against fixed watering holes, poaching declines as poachers can no longer identify where the animal will go to quench thirst.

6. *Water availability needs to turn into water security*

As water becomes available, prioritising its use becomes important. For this agro-climatically suitable cropping patterns need to be adopted and efforts should be made to minimise water use. This is critical for climate resilience.

7. *Waterbodies provide boost for fisheries*

Surface waterbodies created make fisheries possible. This increases the economic benefits. The money generated is additional common financial resource pool that can be used for maintenance of the water conservation structures. Aquatic biodiversity gets a boost and avian species, including migratory birds, can quench their thirst.

8. *Involve the people*

The asset created must be with people's involvement is key. This results in ownership and care of the assets so created. Communities contribute cash, kind, and labour for creation of the structure and with the benefits accrued, can manage the maintenance by themselves. A handover of the assets to communities helps build responsibility.

A. Experience with small ponds

Ponds provide water to humans, livestock, wildlife, plants, and other forms of life, increasing greenery, which in turn slows the rain and nourishes the soil. Ponds reduce possibility and intensity of floods. The heat of the universe makes a balance. The weather improves as local areas become cooler. Ponds provide livelihood and food on the table. There is no displacement of large populations.

The experience of TBS is an example of climate mitigation, adaptation and resilience

In 1986, several wells had dried up in Gopalpura village of Alwar district of Rajasthan, India. Able villagers had migrated to urban areas in search of labour employment. The land lay unproductive and wasted. By June 1987 three large ponds and a small one was made in the village by the people and with the support of TBS. In July meagre 130 mm of rain fell in a span of 48 hours. Because of the ponds, this water found its way into ground, recharging aquifers. Water levels rose in nearby 20 wells and agriculture began on 100 acres of the very same unproductive lands. By November of the same year, this water was used for agriculture downstream and along the pond. In the first year itself, wheat production was possible. Water was available for livestock, drinking water was available for the villagers.

Grass began to grow all along the pond. Trees began to flourish, and the nature ecosystem began to regenerate. The environment improved. Women's work burden of fetching water from far off places ended. Villagers no longer needed to migrate. As the work expanded, other villagers also began to capture the rain for groundwater recharge. Farmers who would work as labour for traders that transported vegetables to urban centres now supply vegetables and other produce which the same businesses transport to agricultural produce hubs in cities such as Delhi.

Continuous work of rainwater conservation has led to revival of small rivers: Arwari, Ruparel, Bhagani, Sarsa, Jahazwali, Sherni and Maheshwara and in Maharashtra to the revival of the Mahakali and Agrani. Healthy and rejuvenated rivers are important for climate resilience. **Flowing rivers act as a cushion against drought and flood, soaking up excess water during heavy rains and releasing water during lean season.**

Over the past 35 years, some 11,000 plus small and large ponds, johads and other water conservation structures were constructed through community driven efforts in the region. The myriad and sometimes unexpected returns on investment over the years, the 'domino effect' in the short and the long term surprised even the TBS team. **This work experience of TBS paved the way for climate change adaptation.**

B. How water conservation led to a climate change adaptation model:

While the benefits of the returns of water conservation were being enjoyed, TBS and the communities, realised the importance of using water judiciously and for this there would a need to take collective decisions and abide with these. Practises needed to be adapted. Behaviour change was essential. Some of the steps taken for this included:

- *Connecting heart, mind and action of farmers with nature:* Along with water conservation works, farmers were encouraged to respect nature and avoid chemicalization and mechanization in agriculture. This change brought about an improvement in the lives, livelihoods, health, and conscience of the farmer. This process of adaptation was made possible by the creation of indigenous fertilizers and seeds.
- *Linking of the crop cycle with the rain cycle:* When local agrobiodiversity is

understood and cultivated, the water use is less. For example, crops of tur, moong, urad, sesame, jowar, bajra were produced more in Kharif, because it takes less moisture from the soil and survives even in drought. In Rabi crops, more promotion was given to gram, mustard crops. In the entire region, the work of growing crops with very little water, not using mechanical energy, was done with the natural energy of rain and sun. The crops cultivated absorb carbon emissions from the atmosphere, which are fixed in the soil. Thus, **it also led to capturing atmospheric carbon.**

- *Formation of river parliament:* To ensure that the river remained rejuvenated, a river Parliament was formed to take collective decisions about water use. Women played a significant role in this Parliament, threatening to leave their spouses if they cultivated water intensive crops.

- *This adaptation was also helpful in preventing drought and flood:* Because of low use of chemical fertilizers, pesticides, herbicides, the water holding capacity of the soil and soil moisture was maintained for longer durations of time. Thus, rainfall could be absorbed, and cultivation made possible due to soil moisture.

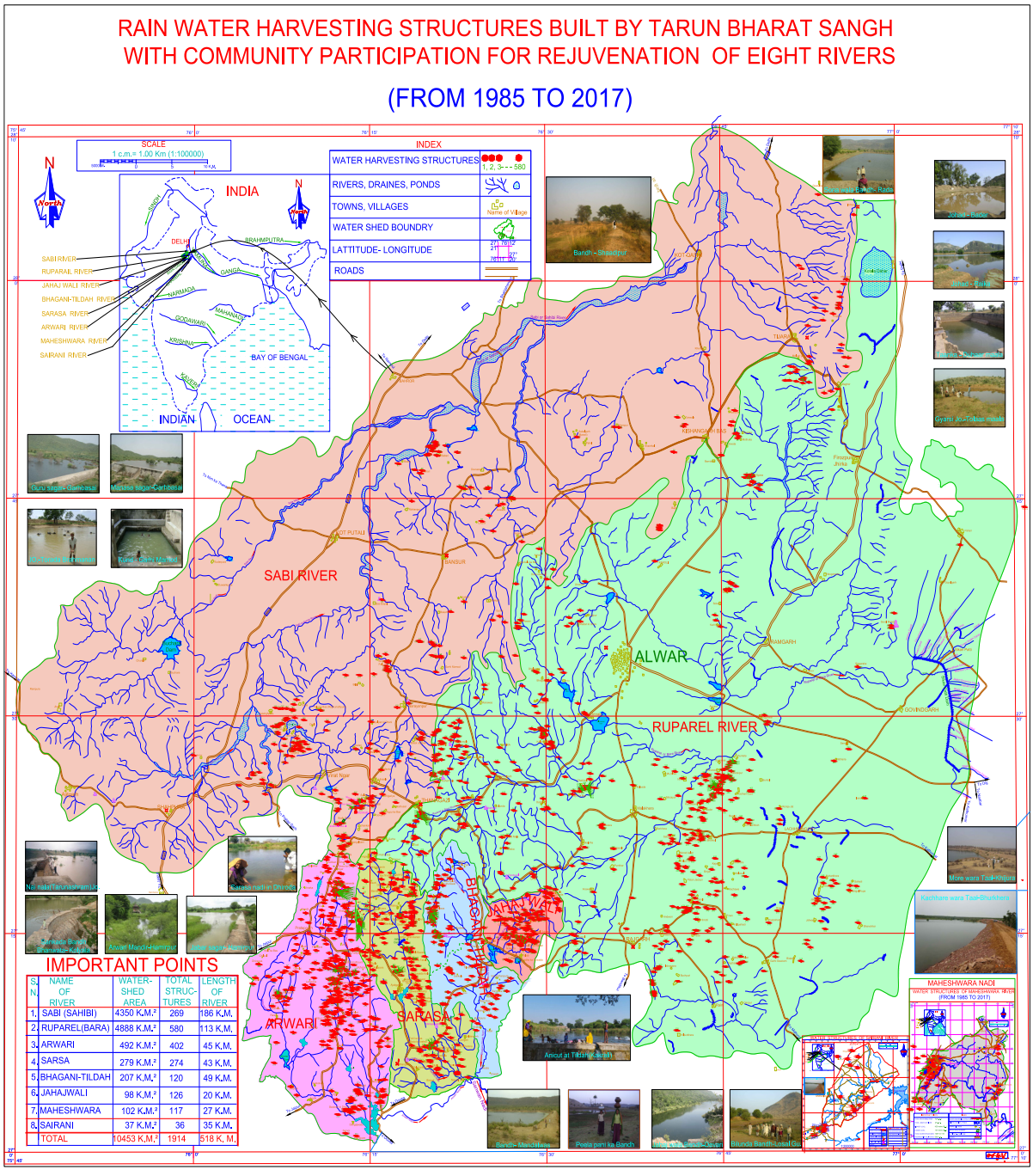
C. With adaptation comes resilience

With the help of TBS, communities contributed both their financial and physical resources constructed 1,914 water conservation structures, which led to revival of 518 km of channels/river length in a watershed development including groundwater development in an area of 10,453 sq km (see map below). This development provided space to store rainwater that flowed from the catchment, leading to groundwater recharge and flow of groundwater to the river in lean season, which in turn has led to the revival of agriculture, animal husbandry, increased tree cover, revival of forests and associated diversity, including wildlife, resulting in economic growth, reverse migration, employment opportunities to outsiders.

Women play a key role in drought adaptation if they have the space to participate

With respect to climate change, it also led to capturing atmospheric carbon.

The area witnessed scanty rainfall in the last three years, but by the judicious use of water (adaptation), by adopting crop pattern with low rainfall, the drought situation was averted, and water was available in small tanks/ponds and the rivers. This year, with the late heavy rainfall during the return monsoon, the tanks are once again full, which in turn will provide water security for subsequent 2-3 years in case of scanty rainfall and with adaptation practises of linking of the crop pattern with the rainfall. **Moreover, with the space created to absorb water, the structures and revived rivers/channels acted as sponges to soak up the water, and thus flooding was avoided.**


RAIN WATER HARVESTING STRUCTURES BUILT BY TARUN BHARAT SANGH
WITH COMMUNITY PARTICIPATION FOR REJUVENATION OF EIGHT RIVERS
(FROM 1985 TO 2017)
SCALE
1 c.m.= 1.00 Km (1:100000)
INDEX
WATER HARVESTING STRUCTURES
RIVERS, DRAINES, PONDS
TOWNS, VILLAGES
WATER SHED BOUNDRY
LATTITUDE- LONGITUDE
ROADS
INDIA
INDIAN OCEAN
BAY OF BENGAL
SABI RIVER
RUPAREL RIVER
JAHAJWALI
ARWARI
SARSA
ALWAR
IMPORTANT POINTS
S. N.
NAME OF RIVER
WATER-SHED AREA
TOTAL STRUC-TURES
LENGTH OF RIVER
1. SABI (SAHIBI) 4350 K.M.² 269 186 K.M.
2. RUPAREL(BARA) 4888 K.M.² 580 113 K.M.
3. ARWARI 492 K.M.² 402 45 K.M.
4. SARSA 279 K.M.² 274 43 K.M.
5. BHAGANI-TILDAH 207 K.M.² 120 49 K.M.
6. JAHAJWALI 98 K.M.² 126 20 K.M.
7. MAHESHWARA 102 K.M.² 117 27 K.M.
8. SAIRANI 37 K.M.² 36 35 K.M.
TOTAL 10453 K.M.² 1914 518 K. M.
MAHESHWARA NADI

Lakes and ponds serve as sponges to soak up excessive water in urban areas, playing a key role in reducing urban flooding and storing the water for subsequent use

The need for cities to have 'sponges' to absorb water

The concept of waterbodies and aquifers serving as sponges to absorb excess water and release it when required in now being used for urban areas also.

Urban designers have articulated the idea of 'Sponge City' designed to withstand extreme flooding [xli].In the article, Scott Hawken, Director of the Landscape Architecture and Urban Design programs at the University of Adelaide in Australia. "It's about working with water intelligently – letting it infiltrate – so flooding is less dangerous."

Sponge cities can boost climate resiliency beyond just flood mitigation. In Austria, sponge projects have proven effective in lessening the impact of flooding's opposite – drought – by filtering and storing rainwater so that it can be used for irrigation and plumbing systems. In Germany's capital, sponge designs, are being used to cool the air in some neighbourhoods. In one of the ambitious projects being executed at decommissioned Tegel Airport in Berlin, this 3 sq. mile development, that when complete climate resilience neighbourhood called the Schumacher quarter with room for 10,000 residents. This will eschew conventional drainage in favour of ground level gradations that will direct rainwater into pools, from where the water will be put to different purposes.

The recent flooding in urban areas has reinforced the need for urbanization planning that keeps intact the existing drainage channels and urban ponds and lakes. It makes even more sense if new waterbodies are created and connected with the existing ones. This will help curtail flooding and save water for the lean seasons, thus creating resilience and even lowering the temperatures of the built-up areas in hot climate zones.

VII. Conclusions

Climate is water and water is climate. The key to mitigation, adaptation and resilience is water

It is the presence of the sun's rays that forests, grasslands, waterbodies, and wetlands thrive. When these are robust and healthy, they fulfil their role in climate regulation. But if we were to look down on the earth, we will see vast lands that are bald due to deforestation caused by over grazing, industrial agriculture, infrastructure creation. This is reducing nature's capacity to play its role and counter carbon emissions. So, it is necessary to rejuvenate waterbodies, recharging groundwater, thereby reviving the natural ecosystems of forests, grasslands, and wetlands: **Developing resilience begins with water[xlii].**

Scientists specializing in conservation, climate modelling and economists form different global institutions have found that nature's ability to mitigate climate change in about 39 per cent more than previously projected[xliii]. **Nature's climate mitigation ability depends on its nurturing, and for nurturing, it needs water.**

It is critical to meet carbon emission commitments. However, this is not enough. We cannot afford a 'carbon tunnel vision approach.' To cool the planet and reduce water-related disasters of drought and flood, the solution lies in greening the earth. For this the key element is water. **Appropriate decentralized water conservation and rejuvenation of rivers/ waterbodies is critical for local climate mitigation, adaptation, and resilience.**

VIII. The People's World Commission on Drought and Flood

The People's World Commission on Drought and Flood (PWCDF) was established during the 2022 World Water Week in Stockholm, Sweden. Under the Chairmanship of Dr Rajendra Singh, popularly known as the Waterman of India, the purpose is to reduce risks to lives, livelihoods, and ecosystems by building community resilience to extreme weather events such as droughts and floods through community-driven nature rejuvenation.

The PWCDF will bridge the gaps between research, knowledge, policy and community action by bringing together communities, scientists, engineers, technocrats, environmentalists, ecologists, social activists, hydrologists, youth and other stakeholders to reduce impact of droughts and floods and build resilience at ground level.

To do this, the PWCDF will:

1. Prepare an annual report on the state of floods and droughts in the world by capturing perspectives through people's dialogues and discussions with technocrats, scientists, ecologists, environmentalists, agriculturists, and decision makers and secondary research.
2. Evaluate and document the various community-centered decentralized human actions that led to nature rejuvenation and resulted in climate resilience.
3. Utilize the information obtained from the community to persuade the state to invest in measures to make communities more resilient to the effects of drought and flood.
4. Encourage students to adopt more environmentally conscious and mindful behaviors by leveraging the educational system.
5. Wherever the demand, create awareness, and train local stakeholders for facilitating ecologically and financially sound, equitable and culturally appropriate community driven nature rejuvenation. The structure of the Commission is decentralised. Besides the Chairman, it includes Commissioners from different macroecological zones that will drive the work based on suggestions that emerge from the Advisory Council and most importantly from the General Assembly composed of persons on the ground. Over time the Commission will develop a vibrant family that believes in engagement, people's perceptions and evidence-based knowledge and action.

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Ali Danish

Revived rivers such as the Sherni revive ecosystems. This river now quenches the thirst of local and migratory birds

People's World Commission on Drought and Flood

visit us at www.pwcdf.org for more details

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