

**Connecting the Dots**

Evolving Practical Strategies for  
Adaptation to Climate Change

## Biodiversity & Adaptation to Climate Change

# About WOTR

Watershed Organisation Trust (WOTR) is one of the premier NGOs tackling water scarcity, rural poverty, and food insecurity in the dry-lands of India today.

WOTR's specific objectives are to regenerate the natural ecosystem with a strong Participatory, People-centric approach that will simultaneously repair the torn social-fabric of community; to address the severe water-scarcity, recurring drought, low-agricultural productivity resulting in starvation, chronic hunger and severe mal-nutrition in the communities; create alternative, diversified livelihood opportunities that can bring the communities out of poverty; through partnerships between diverse groups: villages, NGOs, Government within India and across countries especially South-South Co-operation.

WOTR has specific competencies in Watershed Development and Natural Resource Management, Integrated Water Resources Management, Rural Development, Community Mobilization, Gender and Women's Empowerment, Systems Development and Capacity Building.

In all, WOTR has carried out developmental work in over 2,500 villages in five states of Maharashtra, Andhra Pradesh, Madhya Pradesh, Rajasthan and Jharkhand. In its 18 years since inception, it has organized over 1,100 watershed development and climate change adaptation projects, covering over 680,000 hectares and impacting over 970,000 people. Its involvement in over 8,300 women's SHGs, micro-finance, trainings and other initiatives have benefitted over 100,000 women. Similarly, over 300,000 people from 27 states in India and 35 countries have participated in WOTR's Training and Capacity Building programs.

WOTR has also published a variety of Action Research Studies, films and other communication materials.

WOTR has 184 NGOs and government Project Implementing Agencies (PIAs), which are vital partners in WOTR's extensive development network.

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## Biodiversity and Adaptation to Climate Change

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# Key Messages:

*Biodiversity is key to how well people can adapt to climate change.*

*The poor, the marginalised and the women need to be involved in planning and decision-making so that they may derive sustainable livelihoods from these resources.*

*We need to set different directions for policy, alter incentive structures, reduce or phase out subsidies (that promote wanton degradation of ecosystem services).*

*Establish environmental limits to ensure that society remains within them in order to achieve sustainability.*

*Ecosystem-Based Adaptation (EBA) is an emerging approach that works with nature to help vulnerable communities and build resilience of their ecosystems and livelihoods being threatened by climate change impacts, while also generating significant multiple benefits – social, economic and cultural.*

## Background

Biodiversity is variety of all forms of life. It is the variability among living organisms and their habitats, including the diversity within species, between species and within ecosystems.

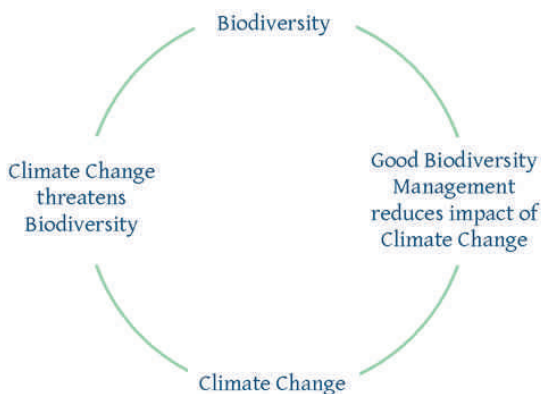
Biodiversity underpins the essential goods and services that ecosystems provide and has value for current uses, possible future uses, and intrinsic worth. There are between 5 – 30 million distinct species on Earth; most are microorganisms and only about 1.75 million have been formally documented.<sup>1</sup> All the interactions between all the components that make up the total global biodiversity set the foundations on which human society has evolved.

The links between biodiversity and climate change run two ways: biodiversity is threatened by climate change, but proper management of biodiversity can reduce the impacts of climate change.

## Biodiversity: to reduce the impacts of climate change

Adoption of biodiversity-based adaptive and mitigative strategies can enhance the resilience of ecosystems and reduce the risk of damage to human and natural ecosystems. Mitigation is described as a human intervention to reduce greenhouse gas sources or enhance carbon sequestration. Adaptation to climate change refers to adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.<sup>2</sup>

Examples of activities that promote mitigation of or adaptation to climate change include<sup>3</sup>, maintaining and restoring native ecosystems (including human beings living in the ecosystems and off them), protecting and enhancing ecosystem services, managing habitats for endangered species, creating refuges and bufferzones, and establishing networks of



<sup>1</sup>[http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy\\_statements/IUCN\\_Guidelines\\_for\\_the\\_Prevention\\_of\\_Biodiversity\\_Loss\\_caused\\_by\\_Alien\\_Invasive\\_Species.pdf](http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy_statements/IUCN_Guidelines_for_the_Prevention_of_Biodiversity_Loss_caused_by_Alien_Invasive_Species.pdf)

<sup>2</sup>Ad hoc Technical Expert Group on Biological Diversity and Climate Change. 2003. CBD Technical Series No.10, Secretariat of the Convention on Biological Diversity. Guidelines for promoting synergy among activities addressing biological diversity, desertification, land degradation and climate change. CBD Technical Series No. 25, Secretariat of the Convention on Biological Diversity.

<sup>3</sup>Ad hoc Technical Expert Group on Biological Diversity and Climate Change. 2003. CBD Technical Series No.10, Secretariat of the Convention on

terrestrial, freshwater and marine protected areas that take into account projected changes in climate.<sup>4</sup>

As an example, several farmers in Akole talukas in Ahmednagar District, Maharashtra plant crop varieties resistant to floods, drought or difficult weather conditions.

Sattechiwadi is a village located in rain-shadow area in Ahmednagar district. It receives an average of about 500 mm rain each year. The climatic condition should preclude growth of rice altogether. However at least one farmer in Sattechiwadi village, was observed to have planted a variety of rice locally known as Dhobal, successfully, for quite some time. This variety is obviously drought resistant, and is also widely grown in village Fursungi of Akole Taluka, which normally receives moderate to high rainfall. The farmers in Fursungi grow nine varieties of traditional/indigenous cultivars of rice to cope with variability in weather. A diverse genetic base together with extensive traditional knowledge is necessary to producing varieties with such characteristics.

## Biodiversity and Ecosystem Services

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Political leaders, policy makers, economists, development professionals and common people do not adequately appreciate the import of biodiversity. The classic example is Biodiversity Act 2002, which is in place. However, it is still not being implemented effectively.

The benefits that we gain from biodiversity go far beyond the mere provision of raw materials.

Ecosystem services provide us resources for living and livelihoods as well as clean up and detoxify the waste that we generate and convert them afresh into usable resources. Human beings benefit from a multitude of resources and processes that are supplied by natural ecosystems. Together, these benefits are known as ecosystem services and include products like clean drinking water and processes such as the decomposition of wastes.

Our **food and energy security** strongly depend on biodiversity. So does our **vulnerability to natural hazards** such as fires, flooding and drought. Biodiversity loss has negative effects on our **health, material adequacy** and it largely limits our **freedom of choice**. As all cultures gain inspiration from, or attach **spiritual and religious values** to ecosystems or their components – e.g. landscapes, trees, hills, rivers or particular species – biodiversity loss also strongly influences our **social relations**.<sup>7</sup>

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### Sattechiwadi's Traditional "Dhobal"

In Sattechiwadi village, several farmers cultivate paddy in *kharif* (monsoon) season. These farmers have very small fields in the main drainage line of village which get flooded for few days and hence they can cultivate only paddy. The field sizes are small, less than 4 acres. Usually they sow traditional variety of rice called "Dhobal". This variety has two cultivars one is white and the other is red.



### Specialties of Dhobal

This rice variety is unique as it can survive in high as well as scanty rainfall conditions. An acre yields 600 to 1000 kgs. It matures in 130 to 140 days. Farmers use organic manure and traditional seeds to grow this variety. This rice is mainly used in their daily meal. It is used for *Kheer* (porridge), *SarBhat* (Curry Rice) or *Masala Bhat* (Spicy Rice). Woman farmers said that when they grind "Dhobal" on their traditional grinder the grains split into two.

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<sup>4</sup>Peoples' Biodiversity Register, Shiswad, Akole 2012

<sup>5</sup>[http://www.unep.org/policyseries/Sustainable\\_intergrated\\_Solutions.pdf](http://www.unep.org/policyseries/Sustainable_intergrated_Solutions.pdf)

<sup>6</sup><http://www.iucn.org/what/tpas/biodiversity/about/biodiversity/>

<sup>7</sup>Millennium Ecosystem Assessment (MEA). 2005. *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington. 155pp.

## Ecosystem Services with reference to living and livelihood in CCA villages

Various ecosystem services which are of great significance from the perspective of living and livelihoods have been observed at the project villages Shiswad, Khadki Budruk and other villages in Akole taluk of Maharashtra. Akole taluk has hilly terrain and is predominantly in non-recharge zone. As a consequence the capacity of ground water recharge is extremely poor. The forests in the region regulate the flow of surface water, which improves its availability beyond rainy season. At the same time, degradation in tree cover however has shortened the availability water in several streams.

Shiswad, Khadki Budruk, Kohane and Purushwadi villages have good soil depth. The soils are also healthy. Consequently the villagers are less reliant on chemical fertilisers. They also use less pesticides as compared to villages where the forest systems are badly degraded. The snakes and birds found in these ecosystems also contribute in controlling pests.

These villages are surrounded by forests. The hills are also relatively free of exposed rocks. The current agricultural practices point to natural systems that contain the pests and protect the health of the soils. The protection of soil health and control of soil erosion is a primary ecosystem service available to these communities.

Studies carried out in the villages of Shiswad, Khadki Budruk and Purushwadi show that people used wild edibles from forests during the time of drought. More than 32 such plant species have been documented in Khadki Budruk village, in the People's Biodiversity Register now maintained by the community.

Several medicinal plants have also been documented. The local healers who have knowledge of the use and practice of these medicinal plants have been using them. The villagers vouch for their efficacy and healing abilities.

The villagers also depend on non-timber forest products like Hirada and Mahalung (known for their medicinal value), Shikakai and Reetha (cosmetic use), Rametha *Gnidia eriocephalus* - used as natural pesticide, Saapkand *Dioscorea bulbifera* used to treat snake bites, Bharangi *Clerodendrum serratum* used to control high fever, Laxmivage fruit *Solanum anguivi* used to treat hyperacidity, Kartule *Momordica dioca* used for diabetes and hyperacidity, Kallavi *Gloriossa superba* roots are used to control hypertension, honey etc. They also use bamboo to make several household items and tools to catch fish etc.

The natural environment provides much aesthetic beauty and a moderate climate. At least three villages have initiated rural and eco-tourism.

The villagers also have a deep cultural connect with their ecosystems.

Wherever these ecosystems have degraded the consequences of deteriorating ecosystem services appear as reduced water availability, poor soil health, disappearance of wild edibles and medicinal plants.

Degradation of ecosystems has also resulted in greater amounts of **human-animal conflicts**. We have documented several cases of wild boars raiding the crops and damage to ground nut in early sowing by peafowls. The menace from black-faced langurs is also faced by the villages of Purushwadi and Shiswad. Additionally a growing number of Leopards in Akole due to anthropogenic interference could be a future cause of serious conflict.

<sup>8</sup> Athreya V (2006) Is Relocation a Viable Management Option for Unwanted Animals? - The Case of the Leopard in India. Conservation and Society, Volume 4, No. 3, Pages 419-423.

Every decision we take that affects biodiversity, also affects our lives and the lives of other people. Biodiversity is crucial to human wellbeing, sustainable development and poverty reduction.

In the long term, the value of services lost may greatly exceed the short-term economic benefits that are gained from transforming ecosystems. When we modify an ecosystem to improve a specific service it provides, this generally also impacts other ecosystem services – often negatively. For example, actions to increase food production can lead to reduced water availability in terms of quantity and quality for other users. This can result in the degradation of many services, such as fisheries, water supply, and protection against natural hazards, seriously affecting people's well-being.

Another example of well-meaning but exceedingly damaging intervention is seen in the afforestation programs often undertaken as part of watershed development projects. The grassland ecosystems are often classified as wastelands. This classification encourages well-meaning proponents of the

projects to initiate afforestation programs. Grasslands are rather delicate ecosystems that are a habitat for myriad species of insects, reptiles, mammals and birds. They also provide other vital ecosystem services like rejuvenating soils and sequestering carbon while laying the foundations for succession of new ecosystems. There is a longstanding relationship of commensalism between grasslands and pastoralists. Afforestation carried out in these grasslands adversely impacts not only the species that depend upon it, but also has serious consequences for pastoralists. Their livestock, now deprived of the mutually beneficial interactions with grasslands, become a source of damage to forest ecosystem.

**The Millennium Ecosystem Assessment (MEA) has broadly identified 24 Ecosystem Services grouped into four types.**

1. Provisioning Services 2. Regulating Services 3. Supporting Services 4. Cultural Services.

The table 1 shows the ecosystem services that are availed by the communities in the project area.



## The Unintended Impact of Development

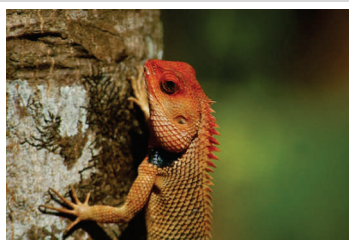
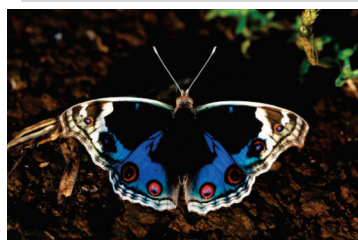
In the villages like Gunjalwadi (Sangamner), Patalganaga (Aurangabad) and Darewadi (Nanded), farmers have dug so many tubewells that it has led to drop in water table. In case of Gunjalwadi post watershed treatment the farmers dug more and more tube wells as the ground-water table improved. Within a few years the water-table plummeted to an all-time low. Deeply concerned the village imposed a complete ban on borewells. The situation has partially improved in the past few years.

At Shiswad, the hill slopes were cleared for agriculture, and this has increased the risk of landslides. The area is already prone to earthquakes due to geological formations and has several faults, lineaments and dykes. Any abnormal movement of earth can easily destabilize some slopes.

Besides this, the extensive tree cutting for various livelihood purposes has also led to a drop in quantity of medicinal and food plants from the forest.

Table 1 Ecosystem Services and their relevance to CCA villages

Provisioning Services	Resources used
Food, Fiber and Fuel	Wild edibles and fuel wood - Akole
Genetic Resources	Varieties of indigenous grains ex. Rice – Akole and Sangamner
Bio-chemicals	Alkaloids from plants used for fishing and Pesticide- Borban (Sangmner) and Akole
Fresh Water	Drinking water in all villages – All Clusters
Regulating Services	
Invasion Resistance	Arrest invasion of Lantana in well forested areas – Shiswad, Purushwadi
Herbivory	Food for cattle
Pollination	Honeybees, butterflies and other insects, smaller birds like sunbirds and white-eyes
Seed dispersal	Birds and small mammals
Climate Regulation	
Pest Regulation	Birds, Snakes and Mammals as predators of pests
Disease Regulation	Control of disease causing vectors like mosquitoes and rats by small bats, owlet and owls etc
Natural Hazard Protection	Forested ecosystems give protection from landslides and floods
Erosion Regulation	Forested ecosystems arrest soil erosion
Water Purification	Spring water is used for drinking in villages such as Khandobachiwadi, Pimpaldari and Gurukul
Supporting Services	
Primary Production	Crops in most of the villages
Provision of habitat	Akole and some villages of Sangamner such as Khandagedara and Malegaon Pathar for Leopard, forest of Shiswad and Akole supports varied range of wildlife from insects to mammals
Nutrient Cycling	Healthy ecosystems of Akole region supports recycling of nutrients like Carbon and Nitrogen
Soil formation and retention	Akole Cluster forested villages such as Shiswad, Purushwadi and Kohane
Production of Atmospheric Oxygen	Clean and healthy air in the villages of Akole is an indication of good content of atmospheric oxygen which comes from the good vegetation of the region
Water Cycling	Healthy forests causing percolation of water and recharging of aquifers
Cultural Services	
Spiritual and Religious Values	Harishchandra Gad of the region is famous historical site of Shivaji's era of medieval India, This region is also a hub of Varkaris of BhagvatSampraday, one of the largest and age old spiritual sect
Knowledge System	Traditional and Indigenous Knowledge in many all the villages of Akole and Sangamner
Education and Inspiration	





# Biodiversity is a Solution That Itself Faces Major Threat

In its 4th Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) states with 'very high confidence' that human activities since 1750 is major cause of worldwide trends of global warming. For the next two decades, about 0.2 °C of warming per decade is projected while the sea level could rise more than 50 cm by 2100. It is also likely that between 20 and 30 per cent of plant and animal species assessed will be at greater risk of extinction if the rise in global average temperatures exceeds 2-3 °C.<sup>9</sup>

The IPCC report suggests that even if greenhouse

As part of building the response capacity of the communities for adaptation to climate change the village youth from more than 60 villages have been trained for risk reduction efforts from disasters of slow and sudden onset. The approach is ecosystems based and promotes restoration of native ecosystems. As a modification of the regular afforestation programmes of WOTR, plant species have now been selected on the basis of geo-climatic zones. This approach might help in restoration of native ecosystems. Installation of energy efficient chulhas in 790 households and Solar parabolic cookers in 21 villages also has an effect of lowering the need of fuel-wood.

gas emissions were to stabilize soon (an unlikely scenario) global warming will persist for centuries, due to the timescales (lags) associated with climate dynamics and feedback processes. The need to adapt to the impacts of climate change is therefore inevitable. It is already happening across the globe. Many people are using natural resources and biodiversity, including genetic diversity, as part of the adaptation process (See Box 1, 2 and 4). For instance, wild relatives of food crops are used to breed new varieties that can cope

In villages like Shiswad, Khadki budruk and Kohane, villagers still use traditional seeds, although in small amount, for their specific qualities. They also use medicinal plants and many of the wild edibles in their day to day life. Traditional rice variety Dhobal sown, by the villagers of Sattechiwadi, can grow in heavy as well scarce rain conditions. Mixed farming of rice and coarse grains like Javas in Sattechiwadi has helped in improving soil conditions. The biodiversity of the region supports wild relatives of grains like udad.

with changing conditions. In many regions of India and the developing world, the rural poor already rely on wild food sources and medicinal plants to supplement diets and maintain health. Some species are used on a daily basis; others gain in importance during periods of drought or stress.

## 1. Climate change: a threat to biodiversity

Climate change is already affecting biodiversity and will continue to do so. The Millennium Ecosystem Assessment (MEA) ranks climate change among the main direct drivers affecting ecosystems. Consequences of climate change on the species component of biodiversity include: (1) changes in distribution, (2) increased extinction rates, (3) changes in reproduction timings, and (4) changes in length of growing seasons for plants.

Some already threatened species are particularly vulnerable to the impacts of climate change and climate variability.<sup>10</sup>

The most obvious, is the effect that changes in rainfall distribution, temperature, flooding and sea level rise, will have on ecosystem boundaries and the functions within them. As a result of these changes in functions and shifts in boundaries, some ecosystems will expand into new areas, while others will become smaller. Habitats will change as rainfall and temperatures change, and some species will not be able to adapt, leading to a sharp increase in extinction rates. Global warming is also causing shifts in the reproductive cycles and growing seasons of certain species, which can in

<sup>9</sup>IPCC (2007) *The Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for Policymakers.*

<sup>10</sup>WWF. *Climate Change. Nature at risk. Threatened species*, accessed online at [http://www.panda.org/about\\_wwf/what\\_we\\_do/climate\\_change/problems/impacts/species/index.cfm](http://www.panda.org/about_wwf/what_we_do/climate_change/problems/impacts/species/index.cfm)

their turn affect how ecosystems function. The equilibrium of ecosystems can also be upset when, for example, insect pests and microbial pathogens previously unknown in a region survive the warmer winters. Migrating species may be affected

Changes in rainfall pattern and temperature are seen in Akole and Sangamner villages as is seen in many other Indian villages. Frost in February 2012 in Akole region is an indication. It will take long time to see visible impacts of climate change vis-a-visa shift in ecosystem/habitats. Yet, changes in the habitat due to agricultural expansion are clearly visible.

Also observed is the shift in species with reference to the habitat. Habitat generalist species like Pied Bushchat, Indian Robin are also spreading in forested ecosystems. Moisture indicator species like moss and lichen have been observed vanishing from the trees or rocks around villages where those were once abundant. That's a clear indication of changing climate. The impacts of climate change on biodiversity will vary from region to region. Species are more likely to become trapped, with no alternative habitat to which they can migrate. Species with small fragmented populations, or populations restricted to small areas, are especially vulnerable to any climatic shifts.

dramatically by any changes to stopover sites key to their survival, or when seasonal availability of food sources is no longer synchronized with migration times.

## 2. Possible Adverse Impacts of Adaptation and Mitigation Strategies on Biodiversity

There is very little literature surrounding the impacts of adaptation and mitigation strategies on biodiversity, as only few adaptation measures have

actually been implemented.<sup>11</sup> However, potential impacts can be identified through our knowledge of likely adaptation measures and the environmental impacts of past management practices.

**There is a need to develop policy for climate change adaptation and mitigation, in which the requirements to perform Environmental Impact Assessments (EIAs), Strategic Environmental Assessments (SEAs) and Systems Analysis as needed, as well as the need to consider ecosystems-based landscape planning where appropriate should be recommended.**<sup>12</sup>

This is based on the recognition that considering biodiversity in the design and operation of the interventions can reduce environmental costs and increase the sustainability of the project.<sup>13</sup> When considering the impacts of adaptation strategies on bio-diversity it is important to consider trade-offs, such as the implications for local incomes and adaptive capacity.

## 3. Invasive Species, Climate Change and Biodiversity<sup>14</sup>

This brings us to another hazard that looms large and threatens to undo many gains of the effort for adaptation and mitigation to climate change. Invasive species present one of the greatest threats to biodiversity and the provision of valuable ecosystem services. The estimated damage from invasive species worldwide totals more than US \$1.4 trillion annually – 5% of the global economy – with impacts across a wide range of sectors including agriculture, forestry, aquaculture, transportation, trade, power generation and recreation.<sup>15</sup> In environmental terms, islands, for example, with their unique and varied biodiversity have suffered disproportionately from invasive species, which are responsible for half to two-thirds of all species extinctions.<sup>16</sup> In comparison, economic projections of global climate-change-induced losses may range from 1-20% of gross domestic product, which is equal to about 5% of GDP annually.<sup>17</sup> These projections should raise alarms for development decision-makers and

<sup>11</sup> Adger et al. 2007; Paterson et al. 2008

<sup>12</sup> Wilson and Piper 2008

<sup>13</sup> Quintero 2007

<sup>14</sup> Burgiel, S.W. and A.A. Muir. 2010. *Invasive Species, Climate Change and Ecosystem-Based Adaptation: Addressing Multiple Drivers of Global Change*. Global Invasive Species Programme (GISP), Washington, DC, US, and Nairobi, Kenya.

<sup>15</sup> Pimentel et al. 2001

<sup>16</sup> Donlan and Wilcox 2008, IUCN 2009b

<sup>17</sup> Stern 2006

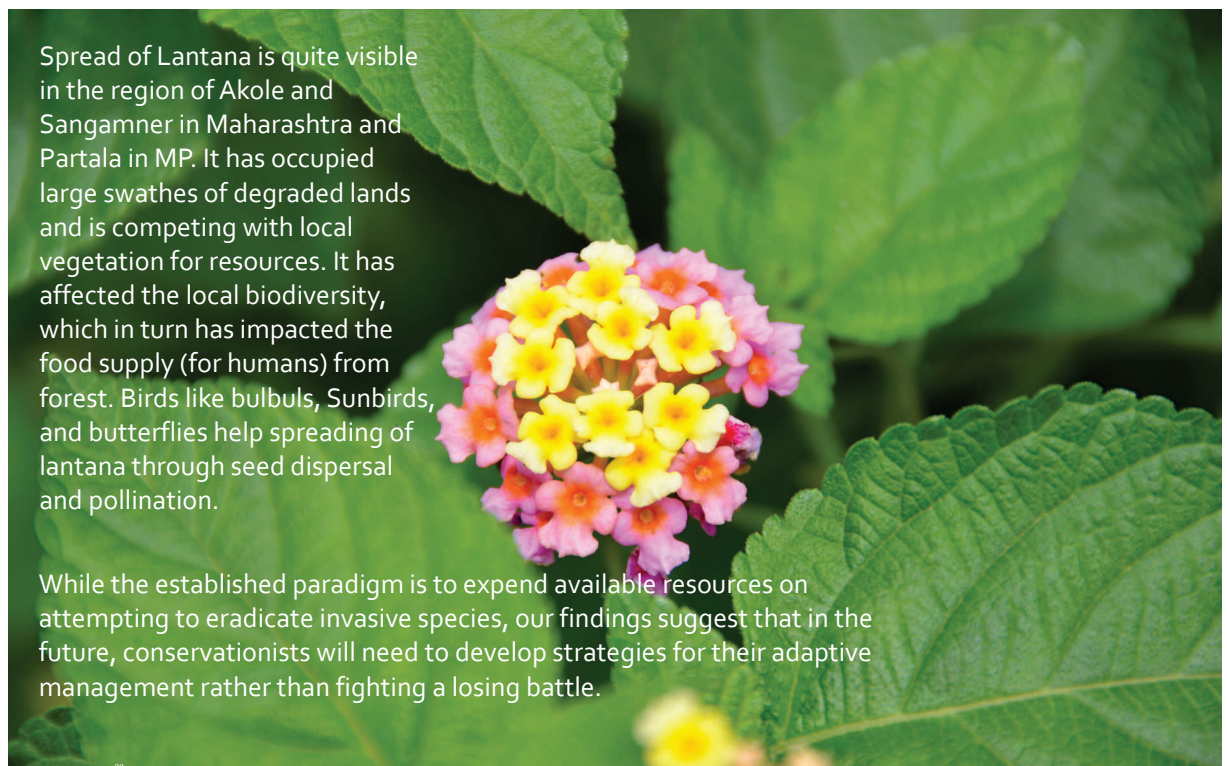
practitioners to take action.

Combined, the complexity of the interaction of the two global drivers – climate change and invasive species – increases dramatically. Climate change would compound the already devastating effects of invasive species. Climate change impacts, such as warming temperatures and changes in CO<sub>2</sub> concentrations, are likely to increase opportunities for invasive species because of their adaptability to disturbance and to a broader range of biogeographic conditions and environmental controls. The impacts of the invasive species may be more severe as they increase both in numbers and extent, and as they compete for diminishing resources such as water. Changes in air and water temperatures may also facilitate movement of species along previously inaccessible pathways of spread – both natural and human-made. Disturbing trends have been noticed in Khandgedara and other villages in Sangamner and Akole taluka of Maharashtra, during the collection of data for People's Biodiversity Registers.

From a food security perspective, there is little point in addressing the impacts of climate

change on the productivity of a staple food if an invasive pest has already decimated the crop. Similarly, from a conservation perspective, there is little point to addressing climate change if the biodiversity we're trying to protect has already been lost to invasive species. Major agricultural outbreaks or health pandemics could result in significant human suffering and loss.

This calls for immediate action. Ecosystem-based adaptation is gaining attention as a cost-effective means of protecting human and ecological communities against the impacts of climate change.<sup>18</sup> Ecosystem based-adaptation builds nature's resilience to the impacts of climate change, while also helping to meet people's basic needs. Invasive species can threaten those basic needs and compromise ecosystem functions by taking advantage of habitat disturbance, species under stress and other weaknesses in otherwise healthy systems. This affects the multiple roles of ecosystems in providing provisioning, regulating, supporting and cultural services.<sup>19</sup> **Such ecosystem-based approaches are not simply about saving ecosystems, but rather about**



Spread of Lantana is quite visible in the region of Akole and Sangamner in Maharashtra and Partala in MP. It has occupied large swathes of degraded lands and is competing with local vegetation for resources. It has affected the local biodiversity, which in turn has impacted the food supply (for humans) from forest. Birds like bulbuls, Sunbirds, and butterflies help spreading of lantana through seed dispersal and pollination.

While the established paradigm is to expend available resources on attempting to eradicate invasive species, our findings suggest that in the future, conservationists will need to develop strategies for their adaptive management rather than fighting a losing battle.

<sup>18</sup> Heller and Zavaleta 2009, Mooney et al. 2009, World Bank 2009

<sup>19</sup> Millennium Ecosystem Assessment 2005, Vila et al. 2009

<sup>20</sup> Bhagwat SA, Breman E, Thekaekara T, Thornton TF, Willis KJ (2012) A Battle Lost? Report on Two Centuries of Invasion and Management of *Lantana camara* L. in Australia, India and South Africa. PLoS ONE 7(3): e32407. doi:10.1371/journal.pone.0032407

**using ecosystems to help “save” people and the resources on which they depend. Such an approach can also provide an integrative framework to address impacts from both climate change and invasive species.**

The three key messages arising from the report prepared by Global Invasive Species Programme (GISP) are:

Climate change will have direct and second order impacts that facilitate the introduction, establishment and/or spread of invasive species.

Invasive species can increase the vulnerability of ecosystems to other climate-related stressors and

Reduce their potential to sequester greenhouse gasses.

For instance, it has been observed that the Lantana is occupying all the deforested and degraded patches of land in the villages Khandagedara, Malegaon Pathar, Warudi Pathar of WOTR's CCA project area. It is inhibiting growth of hard wood species, especially the trees. This results in fragmentation of the habitats for the forest species.

The most notable example is a valley full of lantana in Khandgedara village. This has suppressed the growth of native vegetation. Due to Lantana no one enters in the valley and Leopards have occupied this place. This has increased incidences of human-animal Conflict in the village. The Lantana is also invading the crop fields and affecting the yield of the crop on the fringes. Using an ecosystem-based adaptation approach, these pressures on ecosystems and their ability to provide important services can be offset by

In Shiswad and Khadaki Budruk village people have started using bio-char made up of Lantana. People from these villages found it to be an alternative fuel wood. A youth group from Khadaki Budruk have planned a business enterprise using the bio-char of Lantana.

preventing the introduction of new invasive species and by eradicating or controlling those damaging species already present.

## The Need to Place Biodiversity as a Fundamental Unit of the Economy

The economic invisibility of nature in our dominant economic model is both a symptom and a root cause of biodiversity loss. We value what we can put a price on, but nature's services - providing clean air, fresh water, soil fertility, flood prevention, drought control, climate stability, etc - are, mostly, not traded in any markets and not priced. These “ecosystem services” are all “public goods” provided free.

However, monetizing biodiversity only for provisioning services could easily lead to deprivation of local poor and animals.

Holistic economics, or economics that recognize the value of nature's services and the costs of their loss, is needed to set the stage for a new “green economy”.<sup>21</sup> In order to go ahead with this we first need to fully understand the real values of ecosystem services before monetizing it.

There are difficulties in determining how a market-driven economy can take account of ecosystem services that may not have market values and incorporating this into policy making. Similarly, there are difficulties in understanding how ecosystem services can be maintained or restored through policy or other measures due to the complexity surrounding the study of ecosystems in general.

**The crisis of biodiversity loss can only be addressed in earnest if the values of biodiversity and ecosystem services are fully recognized and represented in decision-**

<sup>21</sup>Greening the economy refers to the process of reconfiguring businesses and infrastructure to deliver better returns on natural human and economic capital investments, while at the same time reducing green house gas emissions, extracting and using less natural resources, creating less waste and reducing social disparities

**making.** This may reveal the true nature of the trade-offs being made: between different ecosystem services (food provision or carbon storage), between different beneficiaries (private gain by some, public loss to many), at different scales (local costs, global benefits) and across different time horizons. **When the value of ecosystem services are understood and included within economic accounting, what may have looked like an “acceptable” trade-off may appear quite unacceptable.**

Conversely, **when benefits that were previously unrecognized become visible (i.e. the role of ecosystems in climate regulation), they become worth preserving.**

Therefore, a cautious approach needs to be adopted when valuing the ecosystem services. Under no

circumstances should any ecosystem be traded to an extent that, left alone, it would not be able to recover.

Further to this, investment in ecosystem protection and management can, with appropriate full environmental economic accounting, yield high returns. For example, recent research findings<sup>22</sup> show that an annual global investment of \$45 billion in protecting ecosystems could deliver an estimated \$5 trillion a year in societal benefits, a cost-benefit ratio of over 100:1.

Many examples now exist of payment for ecosystem services (PES). Here people who manage or interact in some way with ecosystems receive payments for the benefits provided by the ecosystem to the wider community.<sup>23</sup>



<sup>22</sup>The Economics of Ecosystems and Biodiversity (TEEB) Interim Report 2009.

<sup>23</sup>The Economics of Ecosystems and Biodiversity (TEEB) Interim Report 2009



Various non-timber forest produce (NTFP) from the region are traded extensively. Hirda (*Terminalia chebula*) is one of the medicinal plant which fetch some money to the local people.

## Poverty, Gender, Climate Change and Biodiversity<sup>24</sup> Nexus

### 1. Poverty, Climate Change and Biodiversity

Poor people living in poor countries are disproportionately vulnerable to the loss of biodiversity and reduced ecosystem services. While they are responsible for emitting the lowest levels of greenhouse gases, they would suffer most from the impacts of climate change.

The UNFCCC asserts that there are 'common but differentiated responsibilities' for tackling climate change. The Convention on Biological Diversity (CBD) and the Millennium Development Goals (MDGs) offer possible solution to the issues raised. However, these agreements do not specify the strategies and methods to be used by parties to

each agreement to meet their stated aims.

The links between climate change, biodiversity and poverty are clear, and there is an obvious need to support projects and activities that meet the objectives of all three agreements. However, in practice this often not the case. And in some instances, activities intended to meet the goals of one agreement may negatively affect the goals of another.<sup>25</sup>

**The integration of objectives can be improved through stronger linkages between UNFCCC, MDG and CBD through better research and inter-disciplinary thinking and a wider engagement between the public, governments, agencies and other stakeholders.**

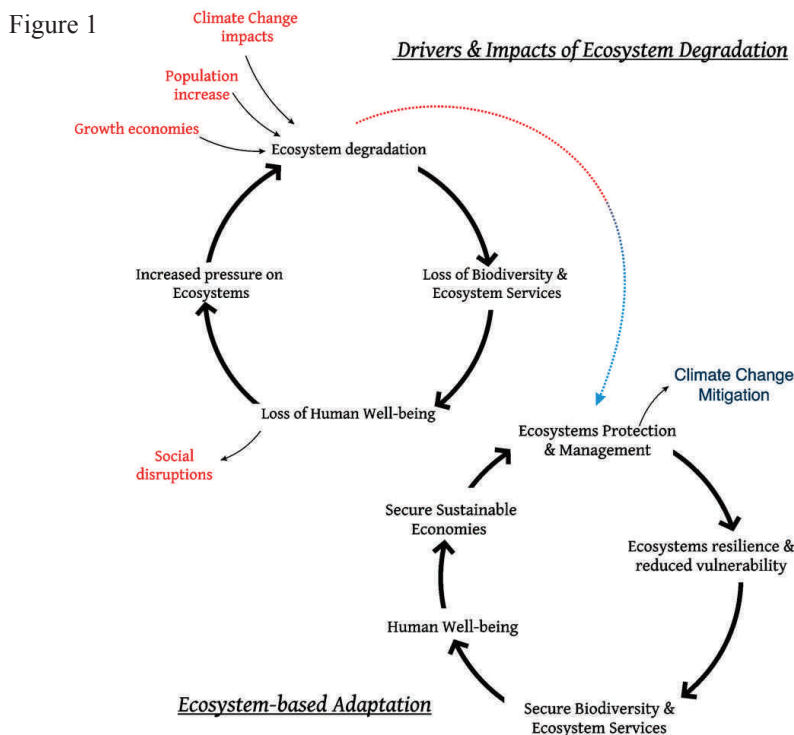
<sup>24</sup>Ecosystem Management: Tomorrow's Approach to Enhancing Food Security under a Changing Climate Richard TingemMunang Ibrahim Thiaw and Mike Rivington

<sup>25</sup>[http://www.unep.org/policyseries/Sustainable\\_intergrated\\_Solutions.pdf](http://www.unep.org/policyseries/Sustainable_intergrated_Solutions.pdf) pp 4,5

Geographic location is a key factor in the vulnerability of poor people and poor nations.<sup>26</sup> Many of these lie in the region's most at risk from climate change. Many of the poor live in marginal areas such as floodplains or at the foot of unstable hillsides. Poor people also have the fewest choices available to them, and the lowest capacity, for example because of a lack of resources and mobility, to cope with climate change related shocks.

Healthy, fully functional ecosystems are better placed to achieve cost effective multiple objectives (ecosystem services), including progress towards food security under a changing climate, than degraded ones. They have underpinned all past and existing economic activity. They will form the basis to achieve long-term economic sustainability while continuing to provide the essential services on which we depend. Local communities should be authorized to manage/collect local ecosystem benefits sustainably. However, inadequate ecosystem protection coupled with a lack of economic mechanisms that does not include the costs of environmental damage, has led to degradation and therefore a decline in ecosystem health and subsequent impact on ecosystem services, thus reducing the ability to feed substantial sections of human society.

The ecosystem management can be defined as “an integrated process to conserve and improve ecosystem health that sustains ecosystem services for human well-being”<sup>27</sup>. Incentives and disincentives should be brought into picture while dealing with biodiversity conservation. Climate change will alter the patterns of net primary production and alter growing conditions for many crops and livestock systems.<sup>28</sup> Healthy ecosystems and their services provide opportunities for sustainable economic prosperity while providing defense against the negative effects of climate change<sup>29</sup> through human adaptation and behavioral change, as opposed to a continuation of degradation (Figure 1).



<sup>26</sup> Haq S, Konate M. et al. (2004) Mainstreaming adaptation to climate change in Least Developed Countries (LDCs). *Climate Policy* 4(1): 25-43.

<sup>27</sup> This is an aggregated definition based on *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. The TEEB Synthesis Report, Nagoya, Japan, 20 October 2010.*

<sup>28</sup> *Ecosystem Health: New Goals for Environmental Management*; Costanza, R., Norton, B.G., Hakell, B., Eds.; Island Press:

<sup>29</sup> Mackey, B. *Connecting Biodiversity and Climate Change Mitigation and Adaptation. Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change.* CBD Technical Series No. 41. Secretariat of the Convention on Biological Diversity: Montreal, Canada, 11 September 2009; ISBN: 92-9225-134-1.

The interventions under CCA in Ahmednagar, Maharashtra and Mandla, Madhya Pradesh (MP) are interdisciplinary. They connect livelihoods, biodiversity, alternate energy, agriculture, and Disaster Risk Reduction (DRR) in a single programme. Activities at various levels involve both, villagers as well as the government agencies.

The DRR approach under the project has a defined component of interactions with the Taluka level government system to integrate the bottom-up community based risk reduction with the top-down District Disaster Management Plans. It sensitizes both the communities as well as the government functionaries to the limitations and strengths that each have.

WOTR's work in developing PBR in various villages is the best example of inter-disciplinary thinking where villagers, government and agencies work together to plan benefits of PBR and address biodiversity concerns in development work to reduce intrinsic vulnerability and enhance the resilience of the natural systems.

## 2. Gender, Biodiversity and Climate Change<sup>30</sup>

Gender roles affect economic, political, social and ecological opportunities and constraints faced by both men and women. Recognizing women's roles as primary land and resource managers is central to the success of biodiversity policy. For example, women currently account for 60-80% of all food production in developing countries, but gender often remains overlooked in decision-making on access to and the use of biodiversity resources.

The importance of biodiversity to individuals varies according to gender. Based upon the social roles of and power relations between men and women, gender is shaped by culture, social relations, and natural environments. We therefore need to incorporate gender dimensions into our understanding of biodiversity and its conservation, sustainable use and the sharing of its benefits. Just as poorer communities disproportionately feel the impact of biodiversity loss, there are also disparities along gender lines. Biodiversity loss affects access to education and gender equality by increasing the time spent by women and children in performing certain tasks, such as collecting valuable resources and services like fuel, food and water.

To conserve biodiversity, we need to understand and expose gender-differentiated biodiversity practices, gendered knowledge acquisition and

usage. Various studies demonstrate that projects integrating gender dimensions generate superior results. Gender considerations are not solely a women's issue; instead, this outlook could yield advantages for whole communities and benefit both sexes.<sup>31</sup>

**Exposing and understanding the gender-differentiated biodiversity practices and knowledge of women and men enhances biodiversity conservation<sup>32</sup> and adaptation to climate change.** Many case studies from around the world and WOTR have demonstrated that in empowering women to participate as equals in information sharing and generation, education and training, technology transfer, organizational development, financial assistance and policy development, biodiversity conservation efforts become more effective and efficient.

**Only with a gender perspective in place can a complete picture of human relationships and ecosystems be built up.**

The Millennium Development Goals emphasize clear linkages between gender equality, poverty alleviation, biodiversity conservation and sustainable development. Such insights should be included into our outlook and approach to reversing biodiversity loss, reducing poverty and

<sup>30</sup> <http://www.cbd.int/gender/why/>

<sup>31</sup> *The Bhoyre Pathar Watershed Project – We Too Can Do It! Achieving Quality Results in Large Budget Short Term Developmental Projects*, WOTR

<sup>32</sup> <http://www.cbd.int/gender/why/>



improving human wellbeing. **Without the participation of women and the realization of their full creative and productive potential, it will not be possible to attain the Millennium Development Goals (MDGs), including those related to environmental protection.**

Women often make their contributions to the family, community and society with unequal access to, control over and benefits from resources and resource use. Women manage households and care for family members, which often limits their mobility and increases their vulnerability to sudden weather-related natural disasters. Drought and erratic rainfall force women to work harder to secure food, water and energy for their homes. Girls drop out of school to help their mothers with these tasks. This cycle of deprivation, poverty and inequality undermines the social capital needed to deal effectively with climate change.<sup>33</sup>



Although the present day economy pulls money out of the villages, WOTR is trying to develop models which attempts to reduce excessive dependence on external economy. The cluster approach and attempts to revive the intermediate markets like haats and country fairs are examples of efforts in this direction.

Nearly 20,000 people participated in the biodiversity festival that took place at Shiswad in December 2011. Transactions on locally made goods and services exceeded Rs 2,00,000.

The CBD further recognizes that women, and distinct groups of women, require special consideration because of institutionalized systems that do not explicitly value women's contributions to biodiversity.

**Therefore, gender equality is a matter of fundamental human rights and social justice. Taking gender into account when considering the environment is a pre-condition for sustainable development.<sup>34</sup>**

## The way ahead

Biodiversity and ecosystem services can be the foundation of many successful adaptation strategies, especially for poor people. They can also deliver climate change mitigation benefits. But meeting all these objectives can be difficult. Adaptation activities in one sector can compromise those in another, as well as mitigation, biodiversity or poverty objectives. Decisions should therefore be based on good science and an understanding of the full environmental-economic trade-offs.

**At the very least, climate change solutions should aim to avoid damaging biodiversity and ecosystem services, increasing inequity and exacerbating poverty.**

This requires a fundamental shift in the structure of the current economic models, where resource consumption is the primary driver, which has led to environmental degradation, biodiversity loss and hence unsustainable societies. Instead **there is need to develop economic models that reverse the market failures of the existing models by fully valuing the environment. They must be able to balance the capacity of the ecosystems to provide essential services with the basic needs of all sections of human society in an equitable way. Such models need to foster greater individual and global collective responsibility and facilitate a shared equity of resource use.**

Governance is a key issue in biodiversity conservation and climate change Adaptation. Governments, individuals, bilateral organisations and the private sector should seek to achieve

<sup>33</sup> UNFPA state of the world population 2009, *Facing a changing world: women population and climate*

<sup>34</sup> [http://www.iucn.org/about/work/programmes/social\\_policy/sp\\_themes\\_ge/](http://www.iucn.org/about/work/programmes/social_policy/sp_themes_ge/)

better integration of information, thinking and decision making to ensure that initiatives, which meet the objectives of the MDGs, the UNFCCC and the CBD, are supported. Currently, however, the bodies responsible for each convention, and the governments and ministers in charge of implementing them, tend to have a sectoral approach, focusing on their own objectives. The synergies between objectives need to be better recognized by governments, who must facilitate change by supporting both top-down and bottom-

WOTR's programmatic intervention in Maharashtra and MP does cover various components ranging from livelihood generation to developing a self-sustaining village. The approach being ecosystem based it automatically conserves biodiversity. As a systemic approach various tools have been tried and tested in Akole and MP, like CASDAAT, PBR, LM<sub>3</sub>, P<sub>3</sub>DM. WOTR has a plan of working on transition ecosystems which are not so degraded.

up initiatives. In order to strengthen it, Gram Sabhas should be empowered while increasing their capacities and capabilities to take decisions consistent with sustainability. Similarly businesses and communities need to take advantage of the economic benefits that the ecosystems-based adaptation approach will bring. Only by collectively addressing the multiple issues of climate change, biodiversity loss and poverty in an integrative way will synergistic solutions be developed.

To improve the outreach of education and awareness various information technology tools can be used at community level.

## Conclusions

The ecosystems play an essential role in enhancing food security. Ecosystems supply the fundamental units of life support, by providing ecosystem services that enable us to produce or utilize food and water. They also provide clean air and climate regulation, shelter and medicines, cultural and aesthetic wellbeing, and can have a vital role in disaster risk reduction. These ecosystem services

are however under increasing pressure and threat of further degradation. As climate change and other pressures bring to bear increasing stresses, we need to ensure that ecosystems do not continue to degrade. Instead we must ensure that they remain healthy and fully functional in order to provide the vital ecosystem services we rely on. We should therefore seek to protect, restore and improve ecosystems, particularly those that have been most degraded.

Given this vital role that ecosystems play in sustaining a growing human society, their current rate of degradation and the emerging threats of climate change, the existing approaches to integrating environmental concerns with economic policy development will be NOT be sufficient by themselves to tackle the problems we face. Instead, whilst the ecosystem-based adaptation approach is not a panacea for all problems, it is one that when integrated with other strategies working towards the same goals (climate regulation, poverty alleviation and sustainability), forms the foundation for a successful integrated strategy for food, water and ultimately societal security.

**Ecosystem management acknowledges the importance of human needs while at the same time confronting the reality that the capacity of our world to meet those needs in perpetuity has limits and depends on the functioning of ecosystems.**

The greatest challenge for governments and global leaders is to adjust national and international economies in line with climate change mitigation and adaptation efforts whilst maintaining ecosystem health and financial stability. Use of the life support services of ecosystems will help economies, financial institutions and societal behavior to make those adjustments in progressing towards a food secure, green low carbon economy, but only if ecosystem health is maintained. Fundamentally, ecosystems form the foundation of life support and hence require appropriate protection and management at a level commensurate with their true value in supporting the global economy. It is vital therefore that the issue of ecosystem management be integrated with other measures to address food security and climate change.



## Engine for Adaptive Sustainable Development

The outer circle, comprising of the five capitals, are the tangible frame within which human life unfolds. The five capitals – the physical, financial, social, human and natural – have to grow and develop simultaneously and harmoniously to have sustainable growth.

A set of five important conditions, essentially interconnected, that are necessary – material adequacy (not merely 'increase'), security (freedom from fear of insufficiency, discrimination and conflict), freedom of choice, healthy interpersonal relationships and good health. These result in an empowered community that lives in dignity and that enjoys well-being.

In the centre is WHOLENESS – a body, mind, spirit integration – a harmony rooted in centredness; the space within which the individual and the community are one with the universe.

When we work to conserve our Earth for the 7th generation, we will be conserving it for ourselves. It requires that we sense, understand and respect the interconnectedness of the various components of the engine and take the necessary steps (adapt) so as to strike the balance that will maintain the equilibrium. We would necessarily need to work together as a community and as a group of communities to achieve sustainability.

*ACKNOWLEDGEMENTS: This image emerged within WOTR after years of deep reflection, while we were trying to find congruence in the way we need to go forward. The thoughts, ideas and mainly sensing of the various components of "The Engine for Adaptive Sustainable Development" comes from the contribution of many across the globe and across times. We thank each of you, some known, most unknown, for permitting us to take your thoughts and to weave it into a meaningful link as we look towards the future of our great, great grandchildren's children.*

# Climate Change Adaptation Project

In ecologically fragile and rain fed regions of India, land degradation, local climatic variations and frequent droughts together with unsustainable resource exploitation have led to severe depletion of land, water and biomass resources thus significantly reducing the availability of water, food, fodder, fuel for cooking and fibres for household consumption and economic production.

In India, the problem is further compounded by Climate Change. The coping mechanisms developed by farmers and all those communities who depend on nature for their livelihoods, are in danger of falling apart. Monsoon and temperature patterns are expected to become and are already becoming more and more erratic. This high unpredictability and variability has implications not just on the weather but also on water, food and agricultural production. The impact of climate change is expected to manifest through deficient and erratic monsoon, change in patterns of pest attacks that will lower agricultural production and productivity, drought and extreme events, triggering a spate of migrations.

The people in the eye of the climate variability storm are the already vulnerable local communities highly dependent on nature and rain.

This Climate Change Adaptation project, thus, seeks to develop the knowledge, strategies, approaches, measures and processes that enable vulnerable communities to cope with and adapt to these impending impacts and which are also widely adoptable, replicable and up-scalable.

This is being achieved through building capacities of vulnerable communities and institutions through watershed and ecosystems based approach. The emphasis is on innovative and people-centred strategies and action. Such innovative activities include downscaling of assessment of impact of climate change, weather based scientific advisories for enhancing agricultural production, biodiversity conservation, promotion of new financial instruments especially weather-linked insurance, carbon neutral communities and disaster risk reduction with effective governance mechanisms.

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