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Filling the Resilience Gap: The Ecosystems Dimension in Food Security Strategy and Policy

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Abstract:

Ecosystem failures including degradation, ineffective environmental governance and natural resource conflict pose a threat to all four components of food security - availability, access, utilization and stability. When ecosystems are degraded, food availability from cultivated, wild and managed food systems is reduced as vital production resources, such as water and soil, decline and biodiversity is lost. These failures result in reduced access to the diverse nutritional benefits of wild foods (including fish, meat and fruits) and to the ecosystem-based livelihood resources, which in turn diminishes the span of the safety net offered by ecological diversity. Climate change threatens to, with its increasing uncertainty and extreme events, multiply these risks. In these circumstances, indigenous people, the poorest people and other marginalized groups are most affected. High levels of food insecurity among the rural poor (who constitute 80 per cent of food-insecure populations) especially among smallholder farming households, pastoralists and landless people characterize the rural areas in many developing countries. However, most food security policies and strategies neglect the ecological dimensions of food security and focus instead on macro-economic and farm productivity dimensions.

This paper argues for a big-picture approach that considers the links between food security and ecosystem dimensions, and their related social, economic and political aspects. Drawing on conservation experience, it illustrates the links between food security and ecosystems and the diversity within them. In addition, it identifies potential benefits and emerging opportunities for a food security approach that includes ecosystems. Using a resilience framework, it demonstrates how better attention to diversity including ecosystem, biological and cultural diversity, natural infrastructure, appropriate organization (and governance), and social learning can benefit food security by facilitating transformation and sustainability of food systems. These benefits include improvements in the three critical securities of food, water and energy, especially for pastoralists, smallholders and indigenous peoples, as well as long-term gains in social resilience through fair and just access to a resilient natural infrastructure.

These findings demonstrate that environmental concerns can no longer be treated as secondary to productivity priorities. Policy and strategic transitions are needed to ensure ecosystem benefits for all four components of food security. Such policies complement and augment the conventional focus on productivity and macro-economic issues. Incorporating ecosystem dimensions requires learning on working with systems and working across scales. More specifically policy developments that recognize the centrality of ecosystem services and goods for food security are needed. This includes better integration of environmental policies with other policies related to improving food security including climate adaptation, disaster risk reduction and trade; more secure land and natural resource tenure; a shift towards collective, collaborative and equitable decision-making at local and transboundary levels so that livelihood needs and rights are better respected; nature-based solutions for adaptation to extreme weather and climate change; interactive and socially appropriate early warning, information and knowledge systems that respect, value and include local knowledge; inclusive planning and decision making systems that focus on learning and effective, long-term responses that respect local rights; and policies to reduce environmental conflict. Policies that encourage investment in off-farm environmental assets will be needed to support these transitions and complement the traditional focus on farm and crop improvements.

1. INTRODUCTION

Contemporary food production practices are failing us.

The failure to achieve the widely-accepted global policy goal of food security – the availability of food that is accessible to all, safe and locally appropriate, and reliable through time and across space[1] – nearly 20 years after its adoption suggests that something is amiss. Even progress to achieve the much narrower Millennium Development Goal 1C, to halve to 10 percent between 1990 and 2015 the proportion of undernourished people, has been slow and uneven. In 2010, 16 percent of the population in developing countries was undernourished, down from 18 percent in 2009 but well above the MDG target of 10 per cent (SOFA 2011). But, overall numbers were up: in October 2010, 925 million people suffered chronic hunger and undernourishment compared to 800 million in 1996 (Vermeulen et al 2012).

BOX 1: THE FOUR DIMENSIONS OF FOOD SECURITY

Availability refers to the 'supply' of sufficient quantities of food of appropriate quality, from both natural and human systems, and is determined by the level of food production, stock levels and net trade, the maintenance of functional ecosystems as well as the social response to climate change and natural hazards such as floods and droughts.

Access is the ability of all individuals to obtain food through their own production, markets, or other sources. Access is dependent on diverse assets and entitlements including financial, natural, social and cultural ones. Social relations and networks within communities and nations, cultural values including at household level, import-export patterns and food prices, human capital such as knowing how the system works and equity is critical in shaping access. Environmental policy defines who can access wild harvested food and derive income from natural resource based livelihoods.

Utilisation refers to the means through which individuals reach a state of nutritional wellbeing and includes the way food is used, food preparation, cultural preferences, and how the body makes the most of various nutrients in the food. Access to clean water and sanitation, energy, and health underpin successful utilisation.

Stability is considered to be the fourth dimension of food security and refers to the stability of the other three dimensions. Good governance, equity, social learning and effective organization are essential for the peace and human security needed to ensure the innovation, fairness and justice, allocation, and ecological resilience needed to ensure availability, access and utilization over time.

This food insecurity burden is not equally shared:

- Girls and women carry seventy per cent of the load (FAO 2011).
- Regionally sub-Saharan Africa and South Asia with 265 million and 642 million food insecure people respectively face the greatest challenge in achieving food security (IFPRI and CCW 2011).

[1] The World Food summit defined food security as the circumstances in which "all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences" (World Food Summit, 1996).

[2] The International Food Policy Research Institute (IFPRI) found in their global hunger assessment, that in this region food insecurity is higher than official numbers indicate, as these figures use income levels as a measure, which is an inadequate proxy for food security (IFPRI and CWW 2011).

But, other regions are struggling too. In Latin America and the Caribbean chronic hunger prevalence was 9 per cent while in the Near East and North Africa it was 7 per cent[2] (FAO SOFA).

- There is significant variation within regions, both within nations and among nations.

Within countries the rural poor are often the most severely affected with 80% being food insecure as against 20% of the urban poor (Sanchez et al. 2005). About half of all food insecure people live in smallholder farming households; roughly one fifth are landless; and a tenth are pastoralists, fisher folk and forest users (Sanchez et al. 2005.) Many of the poorest and most vulnerable are women. For example two-thirds of poor livestock keepers – approximately 400 million people – are women (Thornton et al., 2002 SOFA).

The challenge of achieving a food secure future is growing. By 2050, there will be some 9 billion people in the world. This is predicted to drive up the demand for food crops placing added stress on water and other ecosystem resources. Water demand, for example, is expected to increase by 50 per cent by 2030 under business as usual. Climate change and on-going ecosystem degradation will place added pressures on the resources needed to produce food in both natural and human systems. In 2005 the Millennium Ecosystem Assessment (MA) found that ecosystem degradation is already effecting food production. There are multiple, adverse impacts including the loss of biodiversity that supports food availability and income for over a billion people. Finding solutions that address these growing demands while maintaining the ecosystem services that underpin human and wild produced foods must be a priority.

Although globally, knowledge about how ecosystem services relate to the challenge of securing food for the future has expanded rapidly, policy and practice lags behind. New understandings include:

- The core role ecosystems play in agricultural and livestock production, fisheries, economic growth, human wellbeing and price stability (MA 2005; UNEP 2012; FAO 2012)
- The high dependence the poorest people have on harvesting wild foods (meat, fish and fruits) (MA 2005; Nasi 2011, FAO)
- The significant contribution ecosystems make to livelihoods and income (MA 2005; Arnold 2012).

But, the main food security interventions (increasing farm-level outputs, addressing macro-economic limitations and stability, and developing more secure and efficient supply chains) do not consider how attention to ecosystems can support these objectives and create new avenues for securing food. Further, attention to the environmental dimensions of the multiple risks that affect the achievement of each food security component and its long-term stability including conflict, poverty, inequity in access to natural resources, inequitable economic growth and poor governance is weak. In general, ecosystem objectives tend to be treated separately rather than integrated with other strategies. This is partially rooted in the continued treatment of issues in a silo-like manner among the relevant implementing and policy-making institutions at the national level, but also in poor appreciation of how ecosystem functions impact on other sectors relevant to food security, including trade and development. Biofuel mandates, for example, which are driven largely by energy and price

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concerns have significant implications for food availability and accessibility, as the 2012 drought in the United States of America has shown.

We argue that it is critical to address this "ecosystem gap" if vulnerability is to be reduced and long-term security achieved as the poorest people are most vulnerable where ecosystem dimensions are left out:

- In Part 2 we demonstrate how ecosystems contribute to the four dimensions of food insecurity (availability, access, utilization and stability) and how this fundamental value of ecosystems is at risk from development choices, poor environmental management and governance failures including a disconnect between economic, energy, land tenure, water, poverty, conflict and food security policies.
- In Part 3 we discuss the implications of this ecosystem gap and show that a loss of resilience[3] occurs because the cyclic and interconnectedness of nature and people are not considered. In these circumstances we run the risk of adversely transforming the context in which we live (IIED 2011, Jaeger et al 2012; Rockström et al 2009). Agricultural systems, for example, contribute to climate change-related carbon emissions through land conversion and transportation and thus threaten their own long-term viability (IIED 2011).
- In Part 4, using a resilience framework we identify four points of intervention that can strengthen social-ecological resilience and create new opportunities for achieving food security goals that augment existing approaches. We argue that a shift is required in how ecological systems are considered in development, economic and food policy and in particular a move away from seeing ecosystems and the resources they provide simply as inputs into a human system. This requires a more nuanced understanding of the links between ecological and social systems as inter-dependent with both constantly changing.
- In the fifth and final part, we suggest policy changes that reinforce the links, decouple development and ecosystem disruption, and empower people (and organizations) to be effective actors in achieving food security. We suggest that both better ecosystem management and better governance is required.

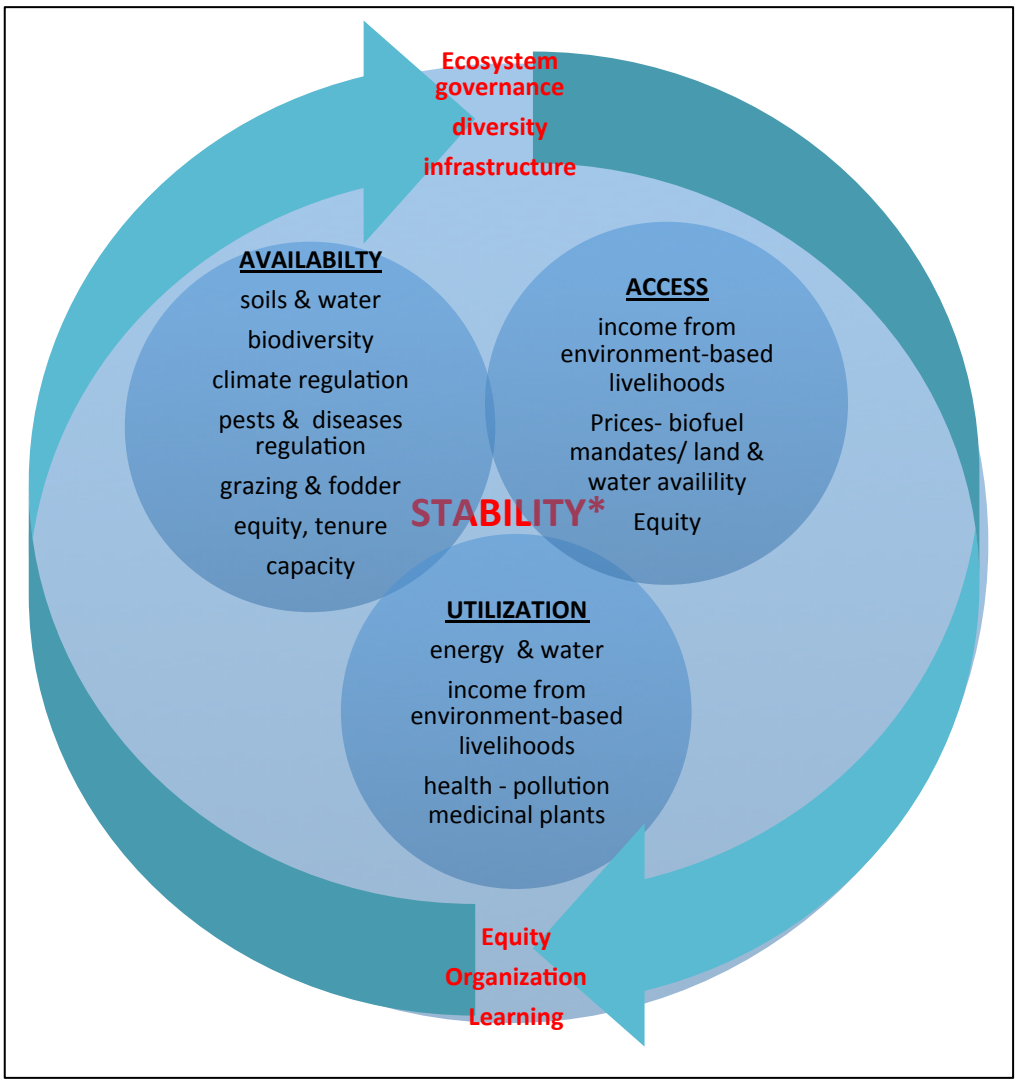
2. WHY ECOSYSTEMS MUST BE INCORPORATED INTO FOOD POLICIES

Food security is the product of many factors, both environmental and non-environmental. Environmental factors – such as climate, soil and water quality, ecosystems integrity, and the maintenance of water flows – play critical roles in shaping all four dimensions of food security (Figure 1). Ecosystems and their services improve food availability, access, and utilization. Ecosystems also affect stability: key risks to food security are shaped by the impacts on ecosystems of inappropriate development and conservation strategies, weak environmental management and inequitable or unjust environmental governance. When sustainably managed and governed

[3] Resilience is used here to not only include the capacity of a system to "absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change" (IPCC, 2008) but to include the capacity for transformation when systems cross thresholds or face "traps," that lead to decline (Folke et al., 2010; Walker and Salt 2006).

ecosystems contribute to stability by the diversity it provides and through natural infrastructure. Effective learning and robust organizations support good governance increase the likelihood of positive outcomes for human wellbeing and reduces vulnerability. In the sub-sections that follow, we illustrate this ecosystem contribution through specific examples.

Figure 1: Ecosystem contributions to food security



*Stability faces multiple risks including from poor environmental management, conflict and poor connectivity between development sectors

2.1 Availability

Food availability is related to the productivity of both cultivated and natural systems. Ecosystems underpin this. Water flows and freshwater availability, ecosystem integrity including at coastal and marine levels, the presence of wild pollinators, genetic and biological diversity, and climate regulation provide the context for agricultural production, livestock raising and the availability of edible plants and animals. The United Nations Environment Programme (UNEP) suggests that securing the balanced delivery of ecosystem services could result in: (1) more efficient use of natural resources such as water; (2) a reduction in the 5-10 million hectares of farmland that are lost each

year due to degradation; (3) fewer yield losses as a result of pests and diseases and droughts and floods; and (4) increased benefits for some of the world's poorest people, particularly women and children (UNEP 2012).

While the contribution of cultivated systems to food security is widely acknowledged and efforts to enhance the productivity of these through better environmental management and governance is receiving greater attention, there has been very much less policy attention to the direct contribution from natural systems to food security. Their critical value for food security is evident, for example, from the significant dependence of rural people on natural systems for food.

Wild animal and plant foods not only provide considerable calories but also much needed protein and micronutrients. Some 4.5 million tons of bush meat is extracted annually from the Congo Basin forests (Box 2). In addition, globally fish provides more than 1.5 billion people with 20 percent of their average per capita intake of animal protein and 3 billion people with at least 15 percent (FAO 2010a). Some indigenous people (e.g. hunter-gatherer forest people in particular) are *entirely* dependent on healthy, bio-diverse ecosystems and species conservation. Poor urban communities also use ecosystem resources to source food, feed and raise small livestock, and supplement income.

BOX 2: WILD FOOD DEPENDENCE

Protein from forest wildlife supports food security and livelihoods across the tropics, providing benefits to local people worth millions of US$ annually and represents around 6 million tonnes of animals extracted yearly. In the Congo basin this amounts to over 4.5 million tonnes/ year and in the Amazon basin close to 1.3 million tonnes. As the table shows rural populations are the primary users.

Table: Estimated bushmeat consumption and wildlife extraction in the two basins

Basin	Dense Forest (km^2)	Population (X1000)		Consumption (tonne/meat/yr)			Extracted (tonne/yr)
		Rural	Urban	Rural	Urban	Total	
Amazon	3 938 000	14 425	24 352	909 000	Negligible	909 000	1 299 000
Congo	1 612 000	57 046	41 199	2 909 000	289 000	3 198 00	4 569 000

Access to bushmeat can be an important coping strategy too with many families also hunting wild game for sale to meet short term cash needs for school fees, festivals, and funerals and to deal with unexpected hardship such as unemployment, illness, and crop failure. This 'safety net' is often most important for the more vulnerable members of a community. In South America, where smallholders sell domestic livestock during times of crisis, maintaining this access helps ensure their food security. In some places seasonal migrants, who have less time for livestock husbandry, rely on bushmeat.

The value of this resource is linked to the availability of alternatives. In the Amazon basin as households have become wealthier the reliance on bushmeat has declined, although it continues to be an important protein source for the poorest and most marginalized people particularly in remote forest areas. In contrast, in central Africa given the extremely small domestic livestock sector, bushmeat remains a crucial component of food security for both urban and rural populations. However unsustainable hunting and deforestation can contribute to the loss of key food species. Most ecosystem processes are driven by the combined activities of many species. Changes in species distribution, particularly the loss of "ecosystem engineers and ecological keystone species" can result in the disruption of ecological and evolutionary processes, changes in species composition, and a reduction in biological diversity creating "Empty Forests". Maintaining ecosystem integrity

is key to ensuring the future contribution of these forests systems to food security. This is particularly important in regions such as the Congo where few alternatives are available. The option of developing a beef industry would require converting as much as 25 million hectares to pastures.

Source: Nasi et al, 2011

Conservation practice, as discussed below, is critical in maintaining this ecosystem value. Equally important is how the links between management and authority is defined and in particular the nature of land and natural resource tenure.

2.2 Access

An increase in food production and availability does not necessarily lead to improved food security and nutrition at the local level as access may be skewed. A range of assets (including capital, financial, natural, and social), entitlements, and market factors such as trade and price shape access to food. For the rural poor, how environmental resources are distributed and governed also defines their use of potentially income-generating natural systems. As discussed below inequity at multiple levels including to land and within households is a critical factor in shaping access to food. In addition the availability of ecosystem resources, such as land and water, as well as environmental policies related to energy and climate change are critical determinants in price.

Ecosystem resources play a significant role in the generation of income needed to buy food. Globally 1 billion people obtain income from the use of wild natural resources (Arnold et al 2011). According to the *World Report on Fisheries and Aquaculture* in 2008, 8 per cent of world population derived their livelihoods from fisheries. Some 44.9 million people were directly engaged in capture fisheries, of which at least 12 per cent were women. It is estimated that more than 180 million jobs are generated in secondary activities, including post-harvest (FAO 2011). As each jobholder provides on average for three dependants, the sector supports the livelihoods of a total of about 540 million people, through primary and secondary activities. The *State of the World's Forests* report 2011 estimates that forest communities produce US$ 75 billion to 100 billion per year in goods and services (Elson, 2010 in FAO 2011). One-fifth of this forest-derived income comes from cash sales of forest products, while four-fifths is composed of products that never enter the market. Traditional forest-related knowledge[4] plays a central role in the commercialization of forest products and forest derived incomes (FAO 2011).

The significance that ecosystem quality, values and governance hold for food prices (and hence access) is seldom reflected in policy even though this impacts directly on energy, transportation and food production costs (Box 3). The 2011 *Global Food Policy* report of the International Food Policy Research Institute's (IFPRI) identifies 4 drivers of price volatility: biofuels policy, climate change, futures trading and several factor related to markets and stocks for the main consumer commodities. Of these both the biofuels policy and climate change have strong ecosystem underpinnings and are linked to poor energy management and macro-economic and development

[4] Traditional knowledge refers to the knowledge, innovation and practices of indigenous and local communities. Such knowledge is developed from experience gained over centuries and adapted to local culture and the environment.

choices over many decades and the resulting decline in ecosystems. The overwhelming global response to managing high and volatile prices has been through trade liberalization, establishing larger food reserves and better-managed grain stocks, the more active use of financial instruments to influence agricultural commodity markets, and stricter regulation of these markets (Torero 2012). But high and volatile food prices have an ecosystem dimension (Box 3).

BOX 3: ENVIRONMENTAL UNDERPINNINGS OF PRICE FLUCTUATIONS

The European and American biofuels policies are a response to the price of energy and climate change. Biofuel mandates have led to an increase in production of crops for biofuel and increased demand for land, water and nutrients and thus the price of other crops (Torero 2012). Price volatility is likely to increase as more countries, such as India and Peru, adopt biofuel mandates (Torero 2012). The expansion of biofuel production that is based on agricultural feedstock and foods effectively tightens the link between prices of agricultural commodities, especially maize which is used to develop ethanol, and developments in international energy markets.

Environmental change and variability are also proving to be significant factors as the reduce land productivity. For example, according to the United Nations' monthly *Food Price Index* (July 2012) global corn prices surged nearly 23% in July, exacerbated by "the severe deterioration of maize crop prospects in the United States of America (USA), following drought conditions and excessive heat during critical stages of the crop development." Mandates for ethanol production are expected to further drive up prices. The renewable energy production in the USA is reported to have reached 15.2bn gallons in 2012, for which it used the equivalent of some 121.9 million tonnes or about 40 per cent of US maize production (Da Silva 2012).

Price volatility makes both smallholder farmers and poor consumers increasingly vulnerable to food insecurity by affecting real income levels and reducing access to food. In these circumstances, farmers may sell productive assets, such as livestock, at low prices and be unable to make investments in measures to improve productivity. The ability to cope with these crises is affected by multiple factors including the existence of safety nets, levels of poverty, and the extent to which other crises are present including natural disasters, ecosystem decline and conflict. Investing in the restoration of ecosystems may not only help avoid price hikes by stabilizing supply but could also be decisive in enhancing coping capacity by diversifying and maintaining income earning opportunities from the commercialization of natural products and securing pasture for livestock.

As with availability, equity is a critical factor shaping access and this is often rooted in environmental entitlements and governance. This aspect however has not received as direct attention at the global level as the issue of price. For example, forest conversion or restricted access to forests can reduce access to forest fruits, a particularly important nutrient source for rural children in Africa's drylands (CIFOR 2012). The importance of inequity is particularly significant where race, gender, origin, and age serve as the basis for social, political and economic opportunity and status.

2.3 Utilization

There is often a hidden assumption in food policy that if food availability and access is achieved then populations will be food secure. Yet the ability to use food effectively for wellbeing including health is often lacking, particularly amongst poor people. Ecosystems have a direct bearing on the utilization of food, including as a source of energy, water and diverse nutrition-rich foods and medicines that support health. For example, it is estimated that in some countries in Africa and Asia

at least 80 per cent of the population depend upon traditional, naturally sourced, medicine for their primary healthcare (World Health Organization, 2008). The quality and diversity of food and medicine may be affected by policy drives towards monocultures as well as the loss of ecosystem integrity. In addition, ecosystems play a critical role in maintaining human health through water purification and disease regulation.

How energy and water resources are governed and managed is critical for utilization as poor people may access these directly from ecosystems for food preparation (Box 4). Environmental and ecosystem-based hazards including pollution, environmental concentrations of chemicals and other toxic hazards, and disease affect utilization. Annually two million deaths are attributable to unsafe water, sanitation and hygiene.[5] The World Health Organization estimates that four percent of the global disease burden could be prevented by improving water supply, sanitation, and hygiene (WHO web). For example 15 per cent of child mortality[6] is attributable to diarrheal diseases; these diseases make the absorption of nutrients difficult. Many of the countries lagging behind on these targets are also countries plagued by environmentally-related conflict or are recovering from such conflict; these include the Democratic Republic of Congo and Nigeria. Poverty is often a critical factor in access to clean water and sanitation, and this in turn may be closely connected to opportunities for ecosystem-based livelihoods. The United Nations Development Programmes *Human Development Report* 2007 found that on average access to clean water for urban households in developing countries was more expensive than for city dwellers in developed countries (UNDP 2007).

BOX 4: DEFORESTATION AFFECTS FOOD UTILIZATION

Access to energy for food preparation for poor people, in both urban and rural areas of many developing countries, is determined by ecosystem quality. Dependence on biomass for energy is linked to sustainable forest management and to natural resource entitlement. Access to fuelwood, for example, affects the choice and range of foods that are utilized including important protein sources such as beans and meat that require higher levels of energy for preparation (CIFOR 2012). In areas where there is deforestation women may need to travel increasing distances from the homestead to collect firewood (Kumar and Hotchkiss, 1988; Nankhuni, 2004. In the United Republic of Tanzania women spend 8 billion hours of unpaid work per year in water and fuel collection and food preparation, which is equivalent to the hours required for 4.6 million full-time jobs (Fontana and Natali, 2008). Investing in sustainable forest management, access to clean water, and the development of food processing infrastructure such as grain milling facilities can help reduce this burden and free women for other activities, including income-generating labour or food production.

Utilization is also linked to the ability to store food effectively for later use, including animal proteins such as fish and cereal crops. Drying and smoking are commonly used techniques for preservation and are energy dependent. Most often poor people rely on biomass for this energy; this makes forest conservation and management critical. Investments in cleaner energy sources for these user communities could reduce adverse climate impacts.

[5] Although the MDG on water and sanitation has been achieved, 783 million people lack access to clean water and about 2.5 billion lack access to basic sanitation (UNICEF and WHO 2012). These global figures are somewhat distorted by substantial improvements in India and China. Many African countries lag behind with some even falling back to pre-1990 levels; 40 percent of all people globally who lack access to drinking water live in sub-Saharan Africa.

[6] Sub-Saharan Africa has the highest rates of child mortality, with one in eight children dying before reaching the age of five compared to 1 in 143 in developed countries (United Nations Inter-agency Group for Child Mortality Estimation. 2011 Levels and trends in child mortality). This is followed by southern Asia with 1 in 15 children dying before age five (United Nations Inter-agency Group for Child Mortality Estimation. 2011).

2.4 Stability

Achieving overall stability of food security is dependent on creating long-term sustainability within social and economic systems and also within ecological systems. This requires reducing the risk associated with food availability, access and utilization over time.

Multiple risks are evident. These risks include factors that affect local vulnerability as identified by the UCFA (violence and warfare, climatic events and natural disasters, loss of assets, unemployment, changing market conditions or inability to work). In addition, deeper underlying determinants are also at play. Social conditions such as inequity, poverty, the lack of health, production and consumption systems, governance systems that marginalize and exclude, weak rights, and poor social relations underpin vulnerability and the lack of the capabilities needed for building resilience (Kok et al, 2007; MA 2005; Sen 1999). Importantly each of these underlying determinants, particularly for natural resource dependent communities, is linked to ecosystem conditions and governance (Kok et al, 2007; MA 2005). In addition "mindsets" about how we manage and use our environment contribute to deep-seated problems such as climate change.

Addressing these risks requires a greater focus on more integrated management and conservation practice as well as addressing the environmental components of other social-ecological risks. These ecosystem-based risks include climate change, adverse weather conditions, ecological degradation, and inappropriate environmental governance including inequitable tenure and decision-making regimes. Other risks with an environmental dimension include land and natural resource tenure, conflict, energy markets, poverty, and social and economic inequity.

2.4.1 Disruption and ecosystem decline in water basins and land and seascapes

The 2005 *Millennium Ecosystem Assessment* found that globally 15 out of 24 identified ecosystem services, including water supply, were already degraded or being used unsustainably (MA 2005). The depletion of soil nutrients, erosion, desertification, depletion of freshwater reserves, the loss of tropical forest and biodiversity were found to be clear threats to food production. Biodiversity decline including of key mammal species in forests and widespread fisheries collapses in both freshwater and marine ecosystems have significant implications for food security (Secretariat of the Convention on Biological Diversity (CBD) 2010; FAO 2012/Aquaculture, Box 5). The transformation of both urban and rural land and seascapes and of water basins through economic and development interventions is a key factor in the decreasing ability of ecosystems to contribute to food security. These findings have been restated by many subsequent environmental assessments (CBD 2010; UNEP 2012/ GEO-5)

BOX 5: MARINE POLLUTION

The Global Environmental Outlook 5 report of the United Nations Environmental Programme reports that little or no progress has been achieved in preventing, reducing or controlling pollution of the marine environment. The number of coastal dead zones has increased dramatically in recent years. Out of the 169 coastal dead zones worldwide only 13 are recovering and 415 coastal areas suffer from eutrophication. Around 80 per cent of marine pollution is caused by land-based activities. This, climate change, and increased catches have contributed to the unprecedented deterioration in fish stocks over the last 20 years (Gaddis et al). Though catches more than quadrupled from the early 1950s to the mid-1990s, they have stabilized or diminished since then – despite increased fishing (Gaddis et al 2012). Some 486 fish are endangered; 1,141 are vulnerable and

60 are extinct (FAO/ State of World Fisheries; IUCN Red Data List)

Prospects for reversing if current practices continue is bleak. Nitrogen-based pollution is expected to increase by 14% globally between 2006 and 2030 (UNEP 2006). In Southeast Asia more than 600 000 tonnes of Nitrogen are discharged annually from the major rivers. As coastal populations increase this amount is likely to rise. The impact on mangroves has been severe, with between 50-90% declining rapidly in most regions in the past four decades (UNEP 2006)

Marine protected areas and integrated coastal zone management areas have proven in many cases to be effective conservation tools, with recent surveys showing higher fish populations inside reserves than in surrounding areas and in the same areas before reserves were established (Gaddis et al 2012; Mohamed-Katerere 2012). Only 1% of our oceans have protected area status.

Transformations of river basins, aquifers and land and seascapes are closely linked to economic policies. Climate change stands out as one of the most significant implications of our economic choices – it is and will continue to opportunities for food security (Box 6). Other processes are also reducing ecosystem potential to augment food security strategies. The privatization of forests, water, the coast and other environmental resources along with tighter control of such resources by state agencies and infrastructural development are removing these fundamental resources from the assets base of poor people. The associated loss of local knowledge about the nutritional value of wild foods affects how these foods are utilized even where they are available and access is possible (CIFOR 2012). In urban areas, where poverty is expected to rise as rapid urbanization takes places (Ravallion et al. 2008) the potential for natural assets to augment income and provide a safety net is also being reduced. Infrastructural development for coastal tourism, for example, increases effluent discharges, disturbs or destroys coastal ecosystems such as mangroves and reduces access to coastal flats, which serve as mollusk-harvesting grounds for local populations. Further, urban food insecurity is made worse by price volatility and an inability of governments to provide services and safety nets (Frayne et al. 2010). One consequence is a switch to high calorie but low nutrient foods, resulting in growing obesity among the urban poor.

BOX 6: CLIMATE CHANGE POSES SUBSTANTIAL RISKS

The potential impacts of climate change on food availability as a result of biophysical changes (increased aridity, higher or lower temperatures, rising sea-levels and an increase incidence in hazardous events, such as floods and droughts) are relatively well understood. For example, it is estimated that by 2050 the number of malnourished children will increase as a result of climate change by about 10 percent, although there will be some variation across different population-economic growth scenarios (CFS on climate 2012). High population ecosystems such as drylands and coastal systems that house about 40 percent of the world population each will be among the worst hit. Countries such as Vietnam, Bangladesh and Egypt, where a large proportion of agricultural production is in low-lying coastal areas, face significant production loss from flooding, sea-level rise and saline intrusion; small island nations are similarly at risk (Agardy and Alder, 2005; Nicholls, 2004).

There is the risk that climate change will set in cycles of decline. Impacts on infrastructure (for food transportation and storage) from hazardous events, reduced state capacity, price fluctuations from energy policy, uncertain yield levels, increases in poverty, and declines in social relations and cohesion could affect food distribution and access. The ability to main a diverse diet and utilize a range of foods, including tubers and animal protein, which is dependent on sufficient access to energy and water for preparation could also suffer. Rising inequity, declining living conditions and related declines in social relations may undermine existing social relationships and generate conflict threatening the overall stability of food availability, access

and utilization.

Already vulnerable groups and indigenous people are at risk. Poor rural women, for example, face loosing title to land in the aftermath of natural hazards that result in a loss of physical control, such as floods, as their rights are often informal (Mitchell 2010; Gondo and Kyomuhendo 2011). Women are also less likely than men to be compensated for such loss as well as the loss resulting from state-led relocations (Mitchell 2010). These conditions as well as other pre-existing constraints in health, education, economic status and so on reduces the ability of already vulnerable people to recover from disasters. This has long-term impacts on productive capacity.

The drive within food policy to increase yield through improved farm inputs and land expansion for commercial agriculture (Bruinsma 2009, FAO how to feed the world) is reshaping the relationship smallholders have with land. In addition, it is disrupting interconnectivity among ecosystems. Many smallholders are disadvantaged through these processes and consequently are not food secure. In Ethiopia and India – both countries are in regions highly vulnerable to climate change – 73 percent and 74 percent respectively of farmers are dependent on the market for food and this makes them also vulnerable to production and market-related risks (de Janvry and Sadoulet 2011). The loss of biodiversity and ecosystem services from the conversion of grasslands, forests and other, so-called "un-productive" land is reducing food security options for local populations. In addition, commercial and export-orientated food production can crowd out resources on which poor people depend (Scherr, Shames and Phemister 2009).

Poor planning, and in particular the failure to take into account interconnectivity between ecosystems and within ecosystems, is a key contributor to this loss of ecosystem services and goods. For example, although water supply is essential for agricultural systems and the maintenance of ecosystems and human wellbeing (Gaddis et al), the development sector does not adequately take account of impacts in other sectors. In addition the multiple pressures on water including population growth, economic growth, urbanization, and industrialization may not be taken into account. One of the most dramatic impacts on the ecosystem dimension of this neglect in development approaches of interconnectivity among ecosystems, across space and time, is pollution from agricultural and industrial choices. This has resulted in increased health risks, agricultural loss, and reduced availability of critical, highly valued, wild harvested food species. This includes the loss of freshwater and marine fish species (Box 5).

Further, the resulting degradation of land, water and marine ecosystems leads to the erosion of both natural and human-managed environmental goods and services needed for food production (UNEP, IIED). For example, polluting agricultural practices not only affect water and soil quality, but can directly reduce food availability by creating unanticipated declines in the supply of wild food by causing ecosystem disruptions. The downstream and coastal impacts of fertiliser runoff, for example, on marine and freshwater ecosystems undercuts the availability of fish and molluscs, critical protein sources for many. About 1 per cent of global land area, which could produce 20 million tonnes of grain annually (1 per cent of global annual grain production) is degraded each year (Panya-Lorch et al 2012) Some 1.5 billion people or 42 per cent of the poorest people live on degraded lands (Panya-Lorch et al 2012) reducing their ability to produce food. There is still a tendency in many countries to exhaust land fertility and then expand the area of land under cultivation rather than invest in maintaining vital ecosystem services. As recognized by the UNGA

resolution on reducing land degradation it is critical to reverse these trends, particularly given predicted increased scarcity under climate change. Otherwise, we will not avoid losing even more valuable ecosystems, including agro-ecosystems, and placing food security under additional risk.

2.4.2 Tenure and natural resource security

The lack of secure land and natural resources tenure, given that they are critical productive resources, stand out as among the most important factor in perpetuating poverty and undercutting all four dimensions of food security. For example, in small-scale fishing communities insecure access rights to fishery resources reduce the sustainability of food production and the availability of safety nets and reinforce exclusion from wider development processes and choices (FAO 2010a).

Tenure regimes vary significantly from country to country and within countries. Over the last ten years significant improvements have been made in community title to forest resources for example, although with poor implementation this has not had expected benefits (Rights and Resources Initiative 2012). In many countries, tenure insecurity continues to be a feature of rural landscapes. In countries where there are layered tenure systems the rights of communities, indigenous people, and the state are often contested. In some countries despite this *de facto* situation, the state claims all legal title as in Ethiopia, Indonesia, Malaysia and Cambodia and Tanzania (FAO HLPE 2011a) and this has led to priorities in food production, such as favouring large scale production over investments in small food producers, that have contributed to local food insecurity (FAO HLPE, Madzwamuse 2010, Cotula). Similarly in the water and carbon sectors, states often claim title over and above the rights of local communities. This can lead to bi- or multi-lateral agreements at the interstate level that exclude or disadvantage local users. International water treaties, for example, while contributing to a reduction in conflict (de Stefano et al 2010) have also led to the relocation of natural resource benefits away from local communities (Mohamed-Katerere 2003). For example, dam construction may increase benefits for commercial agriculture and access to electricity for urban centres, but it can also affect the hydrological system underpinning other ecosystems on which local people rely (Kok et al. 2007)

BOX 7: WEAK LAND TENURE THREATENS FOOD SECURITY

One feature of tenure insecurity is the proliferation of foreign investments in land. Estimates vary greatly from 50 to 134 million hectares; nevertheless the significance is extensive given possible social and environmental impacts. While Africa is hardest hit land acquisitions are also occurring in the Southeast Asia, South America, and Russia. This expansion affects the availability of land, water, and biodiversity for local people reducing productive capacity and the availability of both wild and produced food.

Many of these land investments are for biofuels, extractive industries in minerals and timber sectors and food exports. Often these acquisitions are underpinned by the perception that savannah grasslands are unproductive, vacant or not effectively utilized (Pearce 2012). The biophysical satellite imagery used to determine occupation or use fails to identify the diverse support these lands provide for local people including seasonal cultivation and livestock grazing and the provision of vital environmental services (HLPE 2011a).

Current evidence suggests that these investments have not improved agricultural productivity and have instead adversely impacted food security by effecting food prices and reducing incomes, livelihood diversity and access to environmental resources for local people (FAO HLPE 2011a; Cotula; Headey 2012). These investments disregard the interface between human security, natural resource and ecosystem diversity at a

landscape level and in particular how changing access to land can affect multiple livelihood resources that are critical to food security. For example, these investments can inhibit the performance of the livestock sector by interfering with migratory coping strategies used by pastoralists in times of drought (Headey 2012).

Environmental factors are key in driving these investments. This includes ecological stress, such as water shortages (Smaller and Mann 2009, Woodhouse and Ganho 2011) and drought (HLPE 2011a); environmental policy for nature conservation ((Peluso and Lund, 2011; Corson 2011) and carbon sequestration projects like REDD+ (Larson et al. 2011; Westholm et al, 2011; Corbera et al. 2007); and energy policy including for biofuel production. These drivers are likely to increase as climate change puts ever-greater pressure on land and water resources. A further risk with these investments is that unless they are well regulated, sound environmental management may not be a priority especially where other cheap land is available.

Governance and decision-making systems from which local users are excluded make it relatively easy to extinguish local rights in productive land and other ecosystem resources, affecting both food availability and access. Investors, and other external actors, are often able to secure rights over longstanding rights of local farmers, pastoralist and indigenous communities as they have more resources available to them and greater bargaining power in the negotiation process (Bues 2011).

The lack of access to redress when such rights are extinguished can result in hostile, extra-legal and violent response. In the Indonesian island of Sumatra, for example, following objections by locals to the pulping of over 10 000 km^2 of forest their village was fire-bombed (Pearce 2012). The UN Committee on World Food Security (WFS) has against the background of such concerns issued a set of voluntary guidelines on responsible governance of land, fisheries and forests (Box 8). There have also being significant national developments, for example Ecuador and Brazil, are now imposing new controls to protect citizen interests (Sauer and Leite 2011).

BOX 8: CFS VOLUNTARY GUIDELINES ON RESPONSIBLE GOVERNANCE OF TENURE OF LAND, FISHERIES AND FORESTS 2012

The UN Committee on World Food Security *Voluntary Guidelines on Responsible Governance of Tenure of Land, Fisheries and Forests* are intended to contribute to the global and national efforts towards the eradication of hunger and poverty and the progressive realization of the right to food by improving tenure governance (Article 1.2). They are based on the recognition of the centrality of land to development and are intended to be interpreted consistently with human rights obligations. Several general principles are established that seek to ensure that states recognize and respect all "legitimate" existing tenure rights. This includes safeguarding such rights, promoting and facilitating enjoyment of these rights, and access to justice to resolve infringements or disputes over these rights.

The obligation of non-state parties to respect human rights and to ensure food security is also acknowledged. In addition these parties are required to contribute to positive social impacts and shared value. Transparent processes for accessing and investing in land and other resources are created. These include monitoring, accountability by all stakeholders within a proper business, legal, and regulatory environment; consultation with those affected; and recording and enforcement of agreements from consultations. There is also a specific requirement to quantify environmental impacts and to minimize and mitigating them.

Although these guidelines reaffirm basic human rights principles such as human dignity, non-discrimination, equity and justice, consultation and participation, transparency and accountability when applied to tenure, they fall short of securing longstanding and historical tenure rights. States are encouraged to recognize these rights within state-held land including those that are not legally recognized. States are also encouraged to, in

accordance with available resources, strengthen delivery of services, develop safeguards to protect recognized tenure and equality and non-discrimination in this area, maintain up-to-date tenure information. More participatory, accountable and transparent decision processes in which the rights of affected communities, such as the right to free prior informed consent are recognized are encouraged. However it is important to note that these are voluntary and do not create enforceable obligations

Source: CFS and FAO 2012

The internationally recognized rights to Free, Prior Informed Consent, participation and consultation are only implemented in a piecemeal manner. This makes it difficult for communities to claim compensation that would make it easier to buffer food insecurity. Underlying reasons may include the lack of political will, gaps in the capacity to implement or claim these rights, and weak accountability.

2.4.3 Women continue to be discriminated against

Gender inequity and ongoing discrimination have wider ranging impacts, affecting not only the security of women but also productive capacity and long-term opportunities for building a food-secure society.

The underperformance of the agricultural sector is closely related to the inequity women experience, including in the environmental domain. The 2011 *State of Food and Agriculture* report found that if women had the same access to productive resources as men, they could increase yields on their farms by 20–30 per cent and total agricultural output in developing countries by 2.5–4 per cent. This would reduce the number of hungry people in the world by 12–17 per cent and lift 100–150 million people out of hunger (FAO 2010 –SOFA).

Women seldom have equal access as men to land, natural resources and livestock; education and extension services; and finance and credit. Further they have a heavier workload carrying firewood and water and less access to machinery. Rural women, who produce some 80% of food in developing countries, have title to only a fraction of farmland, and access to just 10% of credit and 5% of extension advice (FAO SOFA 2011). The percentage of women landholders in developing countries (rented, allocate or owned) ranges from less than 5% in North Africa and West Asia to 15% in Latin America (FAO SOFA 2011). These FAO findings on the importance of equity are consistent with other research that shows that equity stimulates growth and improved human wellbeing (Deininger 2003; Jaeger et al 2007). A 2003 World Bank study of 73 countries found, for example, that those with more equitable initial land distribution achieved growth rates two to three times higher than those without (Deininger 2003). Women's rights and entitlements are critical in shaping their access to food (Kabeer, 1994). For example, in Cambodia in 2005, if mothers have no education their babies have 136 chances in 1000 of dying before the age of five compared to a death rate of 53 per 1000 among mothers with the highest level of education (WHO 2008b). The virtually universal bias against females in the allocation of food (Gittelsohn et al., 1997) and the weak access women have to resources have run-on impacts on child under-nutrition, with annually some 3.5 million children die from under-nutrition (IFPRI and CCW 2011, FAO SOFA). Women's coping strategies often depend on access to forests and land and include improving food intake in the hungry season through accessing high energy foods such as palm nuts and sugar cane and planting larger gardens

for vegetables when pregnant (Bentley et al., 1999).

BOX 9: HUMAN RIGHTS APPROACHES

Among the globally significant developments, those related to rights to water[7] and to food[8] stand out as fundamental to reshaping our approach to food security including its ecosystem dimensions. Better recognition of these rights could serve as a check on policy and practice that reduce environmental quality and access to key assets. In addition, these rights could be used to guide priority setting and help governments avoid decisions that increase environmental and other vulnerabilities. The adoption of the *Voluntary Guidelines to support the progressive realization of the right to adequate food in the context of national food security* in 2004 (Charlotte McClain-Nhlapo 2004; FAO 2002; United Nations General Assembly (UNGA) 2007) and those related to tenure in 2012 (Box) provide important guidance for implementation. In 2012 the United Nations Food and Agricultural Organization (FAO) published guidance on how to incorporate this right into food strategies.

The right to food, has been defined by the Special Rapporteur on Food, as "the right to have regular, permanent and free access either directly or by means of financial purchases, to qualitatively adequate and sufficient food corresponding to the cultural traditions of the people to which the consumer belongs, and which ensures a physical and mental, individual and collective, fulfilling and dignified life free of fear" (UN Human Rights Commission 2001)

This right has ecosystem dimensions. As the Right to Food Guideline 8 notes, states have an obligation to ensure that undernourished people have access to productive resources or means for food production, including land, water, seeds, forest areas, fisheries and livestock. Ecosystem quality and governance underpins. Policies and practices that reduce access to these assets or the quality of such assets could be seen to limit this right. This would include policies that unilaterally extinguish existing rights to land, such as forced acquisition of rights in land and forest resources through the designation of protected areas or 99-year or long-term leases of land used by local people.

Further how communities are included in the elaboration of food security policies and programmes is an important part of this right

Environmental change threatens to increase inequity. The insecurity of women (and food production) is made worse when natural disasters such as floods and landslides strike and when a spouse dies as title may be difficult to prove. A reality that will be made worse by climate change and the related increase in forced displacement. Further, as these women may not be able to claim compensation or a right to return when they are displaced, this potentially sets in place a downward spiral of vulnerability (Mitchell 2010).

2.4.4 Inclusion

Where systems of participation, accountability, transparency and legal recourse are weak decisions can foreclose future options by not including local values, knowledge, priorities and needs. The sustainability of ecosystem management suffers where local governance is weak as resource custodians are unable to exclude others, make long-term investments, and enforce their decisions. They are unable, for example, to stop the diversion of ecosystems goods and services out of the local

[7] UNGA resolution, countries

[8] The right to adequate food was first articulated in the *United Declarations of Human Rights*, 1948 and later in the 1966 *International Covenant on Economic, Social and Cultural Rights*. In the Special

economy as a result of centrally determined food, development and conservation agendas. This may adversely affect food production and security even though it may increase GDP. This includes the diversion of water for large-scale irrigation and urban development and restrictive forest access regimes such as REDD. REDD for example, although now expanded from its mitigation focus to include adaptation and conservation concerns, is still largely disconnected from the food security, poverty alleviation and conflict reduction agendas. The continued rapid expansion of biofuel production up to 2050 could contribute to the number of undernourished pre-school children in Africa and South Asia being 3 and 1.7 million higher (FAO how to feed the world). It is still not clear how the aggravated scarcities as a result of these policies and growing land markets will affect social relations. However the history of conservation suggests that such forced exclusions can lead to decades of simmering tensions. Conflict may be generated within communities as some people face reduced access rather than between the community and investor or decision-maker, as has been the case in some conservation projects (Eriksen and Lind 2005).

2.4.5 Environmental conflict

A direct correlation between conflict and food insecurity is now evident (Weisman 2006; von Grebmer et al 2012). For example in sub-Saharan Africa, the three countries not making any progress in improving food security all have high levels of conflict (von Grebmer et al 2012). During periods of conflict productivity in the agricultural sector, although generally less affected than industry, falls in per capita terms by about 1.3 % per year (Teodosijević 2003). Agricultural and food production levels in per capita terms are on average about 10 percent lower during conflict, and in the five years after the conflict, than in the five years before conflict (Teodosijević 2003). In addition, during periods of conflict denying access to both food and food productive resources is frequently used as a weapon. Local conflicts that affect oil production can have global impacts that increase prices of oil (Davies, von Kemedi, and Drennan 2005) and consequently contribute to food price increases.

Conflict is often direct related to the environment, although most often environmental factors act as a multiplier rather than a direct cause. In addition, environmental factors also contribute to poverty, injustice and inequity and are often cited as primary reasons for conflict (Tiltnes and Flat 2010). Adverse social relations around the distribution of natural resources, for example, can contribute to resource-related conflict (Sayne 2011). Land and water based conflicts are expected to increase as demand for these resources increase (due to new population pressures and reduced availability and quality related to climate change (IFPRI 2012/internet on policy trends). Research on rainfall variation in 41 African countries (between1981 and 1999) suggests that there is an increased likelihood of conflict in the years following drought (Satyanath, Miguel, and Sergenti 2004). By the 2050s, water and heat stress due to climate change may reduce grain yields in Asia by 15 to 20 percent by 2050. This along with increased undernourishment is likely to contribute to an increased number of food-and agriculture-related conflicts (IFPRI 2012).

The resulting institutional decline, weakened social relations and cohesion, and violence from entrenched and cyclic conflict also contribute to increased costs and losses in economic growth and food production, make it more difficult for populations particularly women to produce, and reduce access to food resources and the water and energy need for food preparation (Weisman; Teodosijević 2003). In addition, the destruction of rural infrastructure, the loss of livestock,

deforestation, the widespread use of land-mines, the poisoning of wells, as well as population movements compound food security problems (Teodosijević 2003). The constraints experienced by local populations can reduce coping capacity. For example, in the Horn of Africa, persistent conflict reduced the ability of pastoralists to move their herds and also to access affordable food supplies during times of drought (Headey 2012).

Many conflicts are sustained through the pillaging of natural resources, illicit trade in these resources, and land grabbing as in Liberia, Democratic Republic of Congo, Angola and Sierra Leone.

3. THE "ECOSYSTEM GAP" IN FOOD POLICY LEADS TO A LOSS OF RESILIENCE

As shown in the preceding sections by neglecting the ecosystem dimensions efforts to reduce food insecurity and enhance resilience among the poorest people have often failed. The high-levels of vulnerability[9] to food insecurity, especially for the poorest people are linked to (1) dependence on natural systems that are undergoing rapid degradation and change and (2) to how these resources are governed. Changes in the physical context (water, land and ecosystems) from which critical goods and services for development and human wellbeing are (with)drawn affects not only livelihoods but also social relations. The loss of natural capital directly reduces availability of wild foods, genetic plant resources and water as well as the relationships of access within and among communities. Very often the functionality of communities is put at risk and their willingness or ability to take care of the most vulnerable, including women and children, may be threatened where natural resources become increasingly scarce (MA 2005, Sayne 2011).

Although the specific relationship between the ecosystem dimension and social systems varies among communities, nations and regions, nine general patterns related to this symbiotic vulnerability can be identified:

- *Food availability is diminished as ecosystems decline*. Fragile or degraded ecosystems are unable to provide the natural infrastructure needed for availability of food, including of wild food sources and from rangeland and farm-based food production. Farm productivity may not meet its full potential as the availability and stability of vital off-farm resources, such as water provisioning, is threatened. The degradation of freshwater and marine ecosystems threatens the global reliance on fish as a source of protein. Both inappropriate environmental policies and poor management are factors. This includes circumstances in which outside interests are brought in threatening or replacing local authority, sustainable environment management and development activities.

- *Access to food, even where available, may be reduced for both the urban and rural poor,* where development excludes access to food-supporting ecosystems, food prices increase in response to ecosystem-based uncertainties, or incomes decline as natural resource based livelihoods suffer.

[9] Vulnerability is understood to be the product of exposure to social, economic, and environmental hazards, sensitivity, and coping capacity.

- *The safety net availed by diverse livelihood opportunities from natural resource use contracts as ecosystem diversity is reduced*.

- *Environmental governance including exclusionary policies and weak land tenure reduce the incentive for poor or vulnerable communities to make long-term environmental investments needed to improve food production*. One consequence is that a cycle of weakening yields, soil degradation and reduced availability of water lead to spiralling vulnerability. In this context, the ability to cope with floods and drought, and other extreme events associated with climate change including food crises, will be reduced. In the long-term resource-stressed communities are less and less able to move out of food insecurity or poverty - and effectively widening social inequities (Jaeger et al 2007).

- *As ecosystems degrade, diversity within them is reduced and the range of opportunities available to enhance livelihoods and food security is diminished.* Diversity in opportunities is a key factor in adaptation to changing environment and response to environmental, economic and social shocks.

- *Weak or ineffective social organization for governing and managing environmental resources, particularly in the face of on-going change and shocks, can amplify existing risks to food security including inequity and conflict.* Inequity, inequality, exclusion and discrimination have been shown to reduce food production at national and household levels. These factors also shape access and make women, indigenous people, and the rural poor among the most at risk of food insecurity.

- *A lack of flexibility and learning reduces the ability of society to respond to changing conditions, whether in the market or in ecosystems*. Existing governance systems and institutions are often ill placed to deal with the multiple drivers of ecosystem degradation (Ostrom 2012). Actors at the national or regional level often make decisions affecting the sustainability of local food production. These decisions may be driven by values and priorities not shared at the local level. In these circumstances, external decisions can fail to gather traction or to be effective (Patt and Schroter 2005).

Over the last decade there have been several important developments (global commitments and policy-relevant reports) in food policy that address the importance of ecosystems for food security These include increasing acknowledgement of rights and the importance of environmental entitlements (Boxes 8 and 9) as well as better understanding of conservation agriculture, the linkages among energy, water and food and between food and nutrition, and the centrality of ecosystems to livelihoods and food security.[10] Contrary to this, the general ethos within food security policy continues to focus on external inputs and externally driven transformations; little attention is given on how to harness local potential (both human and environmental capacities) to transcend hunger and build long-term resilience. For example, the recommendations of the *State of*

[10] For example, the *State of World Fisheries and Aquaculture 2010* report emphasizes the growing need to focus on the many facets of policy and governance, especially in relation to employment and poverty alleviation and advocates for ecosystem approach in fisheries that contributes to bio-security (FAO 2010a).

Food Insecurity Report 2011, prioritizes a need for increased focus on improving productivity in agriculture, greater (trade and economic) policy predictability and general openness to trade (FAO 2011)

In addition, there is a crisis of implementation: many of the developments at a global level have not been sufficiently incorporated in national policy and practice. While knowledge about the significance of ecosystems to the different dimensions of food security has grown there continues to be insufficient investments in maintain environmental quality, building positive social relationships around its use (institutions, organizations, learning), developing linkages among actors and also among sectors.

Continued policy and practice gaps are evident. These include:

- *The treatment of key risks and issues as sectoral* and as a consequence weak institutional and practical linkages among different development sectors. This includes the weak linkages between food, water, and energy; land degradation and food security; (Nkonya et al 2012; CFS) and food, health and nutrition (Pandya-Lorch et al 2012).

- *Poor integration of ecosystem factors into policies for achieving price stability and enhancing productivity*.

- *Key actors are left out of food security decision-making* and consequently decisions do not always reflect the rights, culture and interests of local custodians.

- *There is little demonstrable global commitment to redress the underlying drivers of climate change* and in particular consumption and productive patterns that use energy unsustainably and that generating substantial waste that the Earth system is incapable of absorbing (Jaeger et al 2012; IIED 2011). The understanding that there are planetary limits or boundaries, which have implications for food security, is largely absent from policy debate and development.

- *Weak recognition of the significance of wild resources for food security for a significant portion of people.* Wild animal and plant foods not only provide considerable calories but also much needed protein and micronutrients, including reliance on bush meat and fish for protein for millions of people (Nasi et al 2011; FAO 2010a).

These policy gaps are accompanied by weak or inappropriate institutional development. In particular institutions lack the ability to respond creatively and flexibly to the uncertainties of climate change. In addition the inability of the world's poorest people to effectively use ecosystems to build their food security is closely linked to social and economic factors outside of their control. These include poverty, land tenure, inequity, environmental governance and conflict – all of which have an ecosystem dimension. Local people are often on the periphery of decision making as participatory and accountable decision-making systems within these sectors is often weak and consequently are unable the risks to their food security from the adverse impacts of agriculture, development, water and energy policies. Moreover they may lack access to information, disclosure and recourse making it virtually impossible to contest the decisions of powerful actors including governments and industry.

BOX 10: ECOSYSTEMS IN THE UN COMPREHENSIVE FRAMEWORK FOR ACTION

The foremost global policy and strategic approach for achieving food security is provided for in the *UN Comprehensive Framework for Action* (UCFA). This provides a twin-track approach that prioritizes: (1) reducing local vulnerability by addressing immediate needs and (2) building resilience and security.

The importance of ecosystems and their management and governance is not well integrated into the framework although it is identified as a necessary outcome for building resilience (Table 1). But, ecosystems also relate directly to Track 1 including in addressing household-level vulnerability related to violence and warfare, climatic events and natural disasters, loss of assets, unemployment, changing market conditions or inability to work because of accident or illness. Similarly the equity dimensions are largely left out with governance and entitlements receiving no attention even though they are central to enhancing human capabilities need for improved wellbeing (Kok et al 2007). Calls for the Right to Food – by the UN Special Rapporteur on the Right to Food, Olivier de Schutter, and Secretary General, Ban Ki-moon –to be recognized as a third track have had little uptake (Golay and Buschi 2012).

Table: Identified outcomes of the United Nations Comprehensive Framework for Action

Track 1 Reducing local vulnerability	***Track 2 Building Resilience and security.***
Outcomes	***Outcomes***
Emergency food aid	Expand social welfare systems
Nutrition intervention	Increase food availability through productive and sustainable small-holder farms
Safety nets	Better ecosystem management for food and nutritional security
Addressing structural problems of dysfunctional systems	Improved performance of international food markets
Outcome 3 – Improving information and accountability system	

Consequently environmental concerns should no longer be treated as secondary to productivity priorities, if vulnerability is to be reduced and long-term security achieved. The idea that there is inevitably a trade-off between agricultural production and productivity and maintaining the environment is now dated, given our current understanding of the dependence of agriculture on wider ecosystems. There is no choice but to do both, otherwise food security will remain a pipe-dream. This requires a shift away from seeing agriculture as an extractive activity to one that is "renewable" (IFAD 2012).

4. ECOSYSTEM FOUNDATIONS FOR FOOD RESILIENCE

The challenge now for policymakers is how to build on the understanding that well-known risks to food security have an ecosystem dimension and that for the poorest and most vulnerable people the failure to take account of ecosystems multiplies their risk to food insecurity. In this section, we present a framework for understanding resilience and illustrate how working with the ecosystems dimension and its social aspects can help address this.

4.1 Understanding Resilience

Resilience refers to the capacity of people and nations to manage uncertainties, to cope with unexpected events associated with global change (including climate change and social and economic **s**hocks and stresses,) and to sustain the transformations needed to reduce poverty, food insecurity and other circumstances that lock people into cycles of vulnerability.

Building resilience requires development and food production models that take into account the cyclic interactions within ecosystems and between ecosystems and human communities. This requires addressing the risks identified in Part 2. In addition understanding how outcomes in one domain or system impacts on others sets the basis for identifying approaches that create mutually reinforcing outcomes across domains. A critical aspect of this is the understanding that food security and development policies can disrupt ecosystem coherence and the resilience of human societies if ecological parameters are not taken into account. Conservation policies can also disrupt ecological-social resilience where insufficient attention is given to social issues. In addition enhancing the capacity to deal with new and unexpected changes and shocks, including from climate change and other risks, will necessarily include the capacity to "re-build" (Smith 2011). We show in the following section how this capacity coalesces around 4 issues – diversity, natural infrastructure, organization and learning.

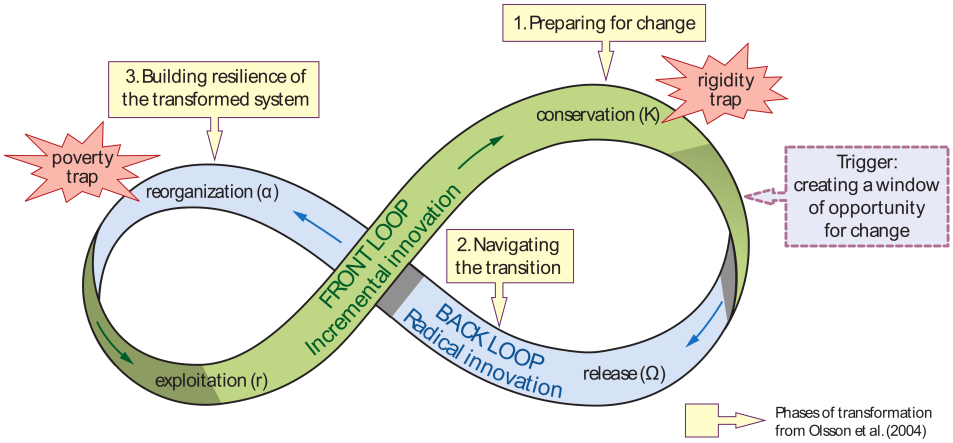
The idea of 're-building', including as necessary re-designing, is a vital aspect of resilience for food security. This is essential for responding to existing "traps"[11] to resilience, such as poverty, as well as in dealing with uncertainty and unexpected events (Figure 2). It is already evident from our failure to achieve food security goals and targets that established ways and prevailing institutional arrangements are inadequate. Existing food systems have often had outcomes that improve one aspect of food security while threatening another dimension or have had positive short-term outcomes that have adverse or negative long-term implications. Road infrastructure development, for example, can improve access to food and improve livelihoods for remote communities, but at the same time these developments can disrupt wildlife habitats leading to the loss of biodiversity if not well planned. Further as the environmental, social, and economic stressors on food associated with global change have become more intense and unpredictable, communities will need to have greater flexibility to adapt – and greater capacity to redesign and re-build.

Adaptation will require not only adjusting to keep things the way they are but taking action to transform communities and economies into configurations that work better (Smith 2011) and are better able to deal with diverse risks with unpredictable outcomes. Strengthening underlying capabilities (Sen 1999) will be essential for this transition. A resilience approach seeks to enhance these capabilities rather than simply responding to specific impacts of adverse changes through, for example, technological change. In this sense it is very different from the impact-specific focused approach that have characterised food security interventions. In addition to looking for a specific

[11] In a social–ecological rigidity trap, institutional and governance controls prevent the flexibility needed for adaptation and resilience (Carpenter and Brock 2008). Such traps include poverty, exclusionary policy, and rigidity in development and economic strategies that lock us into ecosystem decline (Carpenter and Brock 2008, Kok et al 2009). Rigidity traps results from resistance to the adoption of new innovations or approaches because of, for example, large, rigid bureaucracies or powerful groups with vested interests (Holling et al. 2002, Carpenter and Brock 2008). Poverty traps typify a situation from where the social-ecological system is unable to move out of this situation due to a lack of new ideas or an inability to choose an option and act upon it, given a lack of resources, for example.

solution – such as deepening boreholes to address water scarcity – it to seeks to create an enabling context (natural and social factors) that allows communities to reduce risks to their security (Smith 2011).

Figure 2: The Adaptive Cycle



The front loop of the adaptive cycle can be seen as largely characterized by incremental innovation, and the back loop is typically marked by radical innovation. Factors that trigger a switch from the front loop to the back loop often derive from processes operating at larger or smaller scales than that of the system of interest (Holling et al. 2002). Boxes indicate the phases of transformation in ecosystem management identified by Olsson et al. (2004)
Source: Briggs et al

Responding effectively to the risks and challenges for food security will require addressing the overall context of vulnerability including exposure, sensitivity and coping capacity to hazards, shocks and risks. Ecosystems can contribute to heath, access to material (including natural) assets, good social relations, and personal security and consequently the ability of individuals and communities to be effect choice-makers (MA 2005). By virtue of this contribution to human wellbeing, ecosystems can help reduce sensitivity to hazards and improve the capacity to cope with other risks to food security including conflict, weak tenure, and inequality (Kok et al 2010). For example, ecosystem restoration can reduce exposure to specific hazards associated with food insecurity, including for example fisheries collapse from pollution or soil salinization from mangrove depletion or poor dam constriction. Further, improving the availability of information and skills, access to technologies, access to economic resources and the effectiveness of institutions can enhance resilience (Munasinghe and Swart, 2005). In the sub-sections below we illustrate how ecosystems and their governance can help build such resilience.

4.2 Natural infrastructure

Efforts to protect and maintain natural infrastructure are growing, although adoption remains piecemeal the success of such approaches has been demonstrated in very diverse circumstances and places (UNEP 2012, IFAD 2012 and IIED 2011).

Such a focus recognizes that while improvements in food security in the short term depend on

provisioning services (water), long-term secure access to food for all will require regulatory (such as water purification and regulation and climate regulation) and supporting services (such as soil development and nutrient recycling). Focusing on natural infrastructures provides a basis for focusing on these diverse ecosystem services and taking a holistic view of the link among ecosystems and between ecosystems and human systems. For example decision-making related to water allocation, needs to factor in the whole range of ecosystem services that will be impacted. It is against this understanding that well-balanced tradeoffs that don't comprise future resilience can be made.

BOX 10: REDUCING ADVERSE IMPACTS OF FERTILIZERS

The Millennium Ecosystem Assessment showed that there was an inverse relationship between improved food production and soil leaching associated with nitrogen based fertilizers. As soil leaching increased yield levels tailored off. This suggests the need for alternatives approaches. A growing portfolio of experience shows that reducing chemical inputs and managing natural assets in harmony with local ecosystems does not reduce food productivity. For example, in Turkey pesticide use has declined by 30% over the last eight years as farmers were encouraged to move to integrated pest management (IFAD 2012). In the same period Turkey's agricultural GDP has tripled. The Asian Farmers' Association for Sustainable Rural Development, which represents 11 million farmers, reported that in a rice intensification initiative undertaken by over 100 farmers in Cambodia yields went up over 60 per cent despite a drop in the use of inorganic fertilizers of over 70 percent.

Source: IFAD 2012

Ecosystem restoration is about re-establishing these diverse functions. Engaging with local people, utilizing indigenous knowledge and restoring ecosystems can create better synergies between ecosystem sustainability and human benefits. For example, restoring natural infrastructure in rainfed agriculture can be effective in enhancing productivity without expanding land under agriculture. Currently, some 95% of agriculture in sub-Saharan Africa and 60% in India is under rainfed cultivation (Comprehensive Assessment of Water Management in Agriculture (CA 2007). Productivity in these system remains low due to limited water availability at critical growing periods, limited soil nutrient availability and occurrence of pests and diseases – factors related to the degradation of ecosystem services. Halting degradation and restoring ecosystems can help increase soil nutrient availability and the water holding capacity of the soil profile. For example, small changes in tree cover can have a large impact on infiltration and catchment hydrology (Carroll et al. 2004). Indigenous planting techniques, such as the Zaï technique, developed over hundreds of years by local people, builds on the natural processes of soil moisture capture. In the Burkina Faso province of Yatenga this has led to crop yield improvements: average sorghum yields increased from 594 kg per hectare during the period 1984–1988 to 733 kg per hectare in the period 1995–2001 as a result of the adoption of Zaï techniques (Reij and Thiombiano 2003).

Integrated managerial approaches, including to land, watersheds, and coastal systems have been relatively successful in demonstrating positive livelihood outcomes on the basis of ecosystem restoration and sustainable use approaches (Garcia et al 2012; Mohamed-Katerere et al 2012; Box 11).

BOX 11: INTEGRATED WATERSHED MANAGEMENT ASSOCIATED WITH THE TACANÁ VOLCANO GUATEMALA-MEXICO.

Climate change and environmental degradation from inappropriate agricultural and development activities have reduced the opportunities the high-altitude upper watersheds of the Suchiate River and the Coatán, hold for development in Guatemala and Mexico. The related loss in volume and rate of runoff and the lost water storage capacity of the eroded soils exacerbates the risk of flooding caused by intense rainfall. In addition, intensive animal farming and a relatively dense population associated with poor waste and wastewater management is contaminating rivers and affecting fisheries along the Pacific coast.

An integrated watershed management projected started in 2003 under the auspices of the IUCN Water And Nature Initiative (WANI) sort to restore these watersheds as they supply water significant urban populations with water and are the main sources of water for agricultural and livestock production. Restoration has also helped reduce the risk of flooding.

Activities that combine rehabilitation of ecosystem services and more productive and efficient use of water with development of social capital and benefits such as income generation or reduced vulnerability include aquaculture (fish-farming), honey production and agro-ecology (community gardens), reforestation and mangrove conservation, solid waste recycling and septic tank initiatives. For bioenergy and agroforestry production purposes through reforestation, the project took advantage of existing government conservation programs such as the reserve created in 2002 by the Mexican Government in Chiapas and the area of the Tacaná volcano which is protected under federal law. About a dozen forest nurseries were set up, in which 45,000 plants were used to reforest 45 hectares of land with native tree species threatened with extinction (pinabete and white pine).

As a result of IUCN co-executed projects on organic farming, foliar agroforestry and sustainable agriculture, about 43 hectares of land were destined to planting of pasture grass, seed reproduction grounds, protection of water recharge zones through payments for environmental services and construction of water infiltration ditches, and installation of composting beds and stables for sheep. The production of earthworm compost has enabled communities to have continual production of good quality organic fertilizer, eliminating the need to purchase fertilizer made from hen droppings.

Households have now better access to food as a result of greenhouse production, mushroom growing and agroforestry as well as the recovery of the irrigation system. Food is grown within and by the community and the community members year round. Overall, the project contributed to higher resilience of the watershed communities of Tacaná through diversification of agricultural practices (e.g. agroforestry, fruit growing, etc.) for improved nutrition and diversified income generation of a variety of economic activities, including ecotourism and employment in local medium-size estates. To help increase household income generation, women and the young received training on how to start a new business. Gender and age-dependent skills training was vital to curb unemployment and migration

Source: Smith 2011

4.3 Natural diversity contributes to improved food security and resilience

In general, the literature shows that communities and households with diversified assets and opportunities, including natural assets and social networks, are better placed to survive livelihood shocks than those with few assets and no social support systems (CFS HLPE on climate change, Jaeger et al 2007). While external interventions such as the provision of 'safety nets' such as grain or cereal stock holdings can be significant in softening the impact of such crises, (HLPE, 2012) unless

overall capacity with in the local system is built, the ability to rebuild will be limited. Building and maintaining diversity within ecosystems and in landscapes is a critical aspect of this.

Natural diversity can reduce risks and sensitivity to shocks (including price volatility) by providing a base for diverse livelihood and adaptive activities in diverse ecosystems including agricultural landscapes, forests, wetlands, and rangelands. This includes targeted natural safety-net mechanisms secured in advance and in consultation with the most vulnerable people.

The diversity within livelihoods and economies is closely related to ecosystem diversity. Ecosystem diversity supports multiple livelihoods (agricultural, livestock, fisheries, forestry, tourism, hunting), ecosystem viability and wellbeing. For example, the integration of trees in crop fields can enhance nitrogen fixing, tighten nutrient, water and carbon cycles, and produce fruit, fodder, fuelwood and timber have proved to be effective strategies for food security. Repeated shocks and slow onset change that erodes these natural assets as well as social assets make communities less and less resilient (Jaeger et al 2007). As we have shown in early sections these natural assets and services are being eroded due to a combination of economic, social and environmental change.

BOX 11: RESTORING DIVERSITY IN NORTHERN MALI

Over the last 30 years the Nara area in Northern Mali has suffered decreases in rainfall and water levels, land degradation, loss of forest canopy and change in plant species composition. The loss of natural vegetation reduced resilience of the arid zone ecosystems to recurrent droughts and contributed to increased famine, poverty, and migration. Reforesting around 6,000 ha of Acacia senegalensis, a species endemic to the Sahel, has contributed to more sustainable livestock production by increasing the fodder available and to farming through improved soil fertility from its nitrogen-fixing ability. In addition, this acacia's powerful root system makes it efficient for dune-fixing as well as wind and water erosion control. Related project activities including the plantation and nursery management and the production and sale of Gum Arabica are expected to increase local incomes. Payments from Credit Emission Reductions (CERs) will also increase cash in the local economy.

Source: World Bank

In addition, promoting diversity within the cropping system (crop biodiversity, soil biodiversity and pollinators) can increase the adaptive capacity of agriculture against fluctuations in water availability. Restoring biodiversity in agricultural areas, including large mono-cropped areas can be achieved by including natural habitat patches within landscapes, through planting of hedges, multipurpose trees and corridors of interconnecting natural vegetation. Such partial restoration has the advantage of reducing runoff and erosion, helping to protect watercourses and fields (IMWI).

4.4 Robust, fair and just social organization

Strengthening local organization is particularly important for building resilience as it increases the ability to self-advocate, negotiate fair trade-offs, set shared priorities, and make the redistributive choices necessary foe enhancing food production. Consequently, it increases the likelihood of effective response to change, problem-solving and durable social relations.

Local organization is important because very often it is local people who best understand their use of and reliance on wild resources and how this is changing in response to social and environmental factor. For this reason these users provide critical insight into the nature of the problems faced, the

plausibility of solutions and the effectiveness of potential responses to food insecurity. In addition where local groups are directly involved in governing they are able to enforce rules and incentives needed for the sustainable management of landscapes and ecosystem services and goods on which food availability and access dependent. When these rules are locally defined and directed there is more likely to be support for them among land and other natural resource users (IIED 2011) and for them to more effectively address the drivers of degradation. In the absence of local consultation projects that seek to improve livelihoods and coping capacity may fail.

Formal decision-making regarding food insecurity tends to be taken at global or national level. However, given that the potential for achieving food security is based on the feasibility and compatibility of decisions made at different levels, including the local level, it is critical that institutional arrangements facilitate engagement among diverse actors. In addition, the inclusion of local users and custodians – farmers, pastoralists, forest people, shifting cultivators, fisher folk and other food harvesters and producers – at these 'higher' levels can support more appropriate decisions. To be able to engage at these different levels will require investments in and support for these local organizations to, for example, strengthen their negotiating power within markets. In the absence of such organization these food producers and harvesters are invisible not only in the policy process but also in the context of mainstream development programmes, innovation systems, and so forth (IFAD 2012). Engaging with local organization requires transitions in values and attitudes. This includes, for example, recognizing the value and potential role of local/traditional/community level knowledge in defining food security strategies.

Robust organizations are also critical because ecosystem change – whether negative or positive – can lead to changes in social relationships. For example, ecosystem restoration increases the diversity and quality of assets and this can increase the likelihood of new claims or the resurrection of old claims related to the use of resources (WRI 2008). This can lead to resource competition and conflict (Sayne 2011). Legitimate – locally recognized and supported organizations – are often the missing factor in managing these differences and explain why some societies are better able to manage these differences (Jaeger et al 2007). Robust local organizations and institutions can help manage new demands and competition around these resources as well as help communities resolve differences about management and priorities. For example local organization is often better able to define rules that are locally acceptable (Box 12). The recognition and support for local organization is often also consistent with the cultural rights of local people and indigenous people to pursue their own management and decision-making systems. Similarly local organization is also critical for negotiating and managing scarcity in the context of environmental and economic uncertainty.

BOX 12: RANGELAND RESTORATION IN BARA PROVINCE, SUDAN

Following the successful restoration of rangelands in Bara Province of North Kodofan state, nomadic tribes from other areas moved into these lands seeking access to grazing. The community who had restored these lands was able to successfully negotiate access with the outsiders. A key factor was the strength of their local organization and in particularly their traditional normative and governance system. Local norms included the sharing of water, rangeland and fire amongst all peoples. As a result, the newly settled pastoral community was not excluded from use, however their use was defined by local rules. *Ad hoc* cooperative working-groups called Nafeer (or Nafir) were created to address issues of harvest, disasters and any sudden or unexpected event. To date, there have been no conflicts over resources in the project location

Source: Buffle and Elasha 2011.

Such organizations can also help other vulnerable groups, such as smallholders including women farmers, overcome social and economic constraints. For example, in the Indian dairy industry establishing women's organizations helped members overcome constraints to their access to services and credit (Arpi, 2006). The new cooperative structure reduced the risk for actors at the lower end of the chain while enabling them to contribute to increase the availability of livestock products through new markets.

4.5 Social learning provides a platform for effective response

Finding solutions to complex problems is not always easy. Many different options are available. Identifying the most appropriate option will depend on technical supportability, local values, national and local priorities. To a large extent this is dependent on interactive societies in which learning and information exchange among and within levels inform decision-making.

Existing policy and decisionmaking systems however tend to be hierarchical, with solutions often imposed. Policymakers and businesses may have minimal or no interaction and dialogue with the community who will be affected by the decision. Social learning can help ensure that diverse and multiple options are considered by ensuring inclusive and collaborative approaches. It can also ensure that solution found is locally appropriate. Local people often have a more accurate understanding of key vulnerabilities, environmental change and relative risk, and their use and reliance on ecosystem and other resources. Experience in the adaption field illustrates the importance of this (Box 13). In the food security domain issues of risk perception and acceptance are also important. Achieving shared understanding – and hence learning – among policy makers, technical agencies and communities requires processes and investments that support this.

BOX 13: LOCALLY INCLUSIVE PROCESSES ARE NEEDED FOR STRATEGIES THAT ENHANCE RESILIENCE

Experience with the government-initiated resettlement scheme in Mozambique following Cyclone Eline in 2000 illustrates the problems associated with decisions that ignore local perspectives (Patt and Shroeter 2005). Two million people were effected - more than 7000 people were stranded in trees for several days, 800 people died, and hundreds of thousands were left homeless. Over 90% of the irrigation systems in Mozambique were lost. Given the risk of flood and to reduce the high level of exposure the government in conjunction with the donor decided to build resettlement villages on higher ground. But few people moved in and of those who did many subsequently left. For farmers the "risks" associated with this relocation outweighed the perceived danger of staying in the floodplains. These included the loss of easy access to fertile land and the disruption of community and hence diminished social support. Other adaptation strategies also did not garner support: the benefits of alleviated grain storage to save them from floodwater did not deal with the challenges of high winds nor had the issue of pests been factored in. Another challenge was that farmers and policy makers disagreed about the seriousness of climate risks. A project to provide more information about climate change to farmers did not change their beliefs. The results highlight the need for active dialogue across stakeholder groups, as a necessary condition for formulating policies that can then be successfully implemented (Patt and Shroeter 2005)

The lack of voice that communities have reduces opportunities for social learning. Opening up policy processes to more diverse forms of knowledge, requires acknowledging and recognizing the legitimacy of a variety of systems of knowledge and experience (IIED 2011). More discursive processes are needed to facilitate such learning (Table 1). Such participatory communication and

horizontal knowledge sharing may be complement by information sharing, for example regarding existing policies, technological know-how, and the hazards and risks faced. This can widen the range of solutions considered by helping strengthening understanding of the local situation including factors that may fall outside of local experience (such as human rights law). Collaborative learning and decision-making supports local planning to improve their condition and the effectiveness of society (Fraser and Restrepo-Estrada 1998). An example of this approach is the collaborative knowledge and information initiative in the Sahel between the World Meteorological Organization and the Indigenous Peoples Africa Coordinating Committee, in which the parties share knowledge and information related to weather changes. This is designed to help pastoral people determine migratory routes for livestock and prepare for adverse climatic events.

Table 1: From diffusion research to a process of innovation

Conventional steps in the adoption and diffusion of research	→	Steps to encourage new understanding as basis for innovation
Knowledge	→	Working with people to identify and agree on problem or issue and its nature
Persuasion	→	Thinking about and mapping network of actors affected by problem or issue
Decision	→	Engaging with actors in defining ways to affect change and enhancing existing communication
Implementation	→	Address the social (and environmental) costs of change
Confirmation	→	Critical evaluation and review

Adapted from Leeuwis, 2004

5. A FOOD SECURE FUTURE

Ensuring a food secure future requires a paradigm shift in how we think about ecosystems and food. In this section we look at the opportunities our understanding of the ecosystem-food nexus provides for finding solutions to the challenge of feeding a rapidly growing population. We then suggest several policy transitions needed to facilitate such an approach and in particular to support the four dimensions of social-ecological resilience identified in the previous section.

5.1 Emerging Opportunities

Existing interventions and investments in ecosystem management, as discussed, hold critical lessons for strengthening food security, as they form a direct link between the social and environmental dimensions of development.

It is critical that we move away from seeing ecosystem assets simply as *inputs* and the services provided by ecosystems as *limitless*. Instead we need to focus on how these ecosystems fit into the

overall system, and the costs for food security of their unsustainable use. Closely related to this is how we manage wastes and by-products of food production, including pollution. Our management systems need to reflect this understanding if human wellbeing and the sustainability of the planet is to be achieved (MA 2005, Jaeger et al 2012).

A shift to thinking in terms of systems demands *seeing the links* between ecosystems as well as between social and ecological resilience. This means shifting from a focus on the protection of discrete ecosystems to management of larger landscapes—addressing them in bundles of interlinked services, including those that support food production. This emphasizes the *connectivity* with in landscapes but also between land and seascapes. It also requires making choices that factor in other processes of change with in political, social, and economic domains and that consider the links that food security has with different economic or development sectors such as energy, water, and health. Understanding the linkages between decisions and practices across scales – local, national and global – requires a shift away from decision-making at only one level to more inclusive, interrogative, and discursive processes (such as social learning). But such interaction can be ineffective where there are large discrepancies in power. This includes disparities among states and state agencies as well as between the state and non-state actors. Strengthening local organization and enhancing the voice of smallholders and natural custodians, who are the managers of food production both in the wild and on farms, is critical for sustaining these resources and managing conflict. In particular, opportunities for sharing information, learning and defining solutions need to be enhanced. Collaboration can be supported by building more robust local organizations and specifically recognizing their rights to information, transparency, accountability, participation and recourse; securing resource entitlements; and improving equity.

Similarly there needs to be a transition in how we identify and solve problems. This is essential in order to identify the most appropriate solution – a triple win for food security, ecosystems, and long-term resilience – from a broad range of options. As discussed interactive and discursive learning processes can support this.

Critically a systems approach *requires we move away from a juxtaposition of key determinants of wellbeing. The choice cannot be conservation or development. It needs to be both* – and this needs to take place in ways that support long-term sustainability and resilience. It requires a shift in how we approach ecosystem management and conservation. These domains need to be opened up to ensure better linkages to food security and nutrition and other social objectives. The value of nature as productive assets, as safety nets and as a basis for diversified livelihoods – and the necessity to maintain this asset – must be part of an approach to food security. This does not mean abandoning the protection of particularly fragile or threatened ecosystems, but it does mean looking at protection as one tool in recovering and maintaining ecosystem services, and considering interactions between protected areas, neighboring agro-ecosystems and other sustainable managed ecosystems. In addition it will (as discussed) require better attention to restoring and maintaining natural infrastructure and diversity. *This will require supporting ecosystem approaches across scales including at farm and the macro-economy (current focus of attention), but also between landscape and watershed and sea and landscape.*

At the same time there needs a change in how we approach food production. This means seeing our

managed *agricultural systems as agro-ecosystems that provide a wider variety of services* (UNEP 2011, IIED 2011, IMWI) and that are linked to other ecosystems. This kind of landscape approach can make it easier to identify and act on opportunities for synergies among crops, fish, livestock, and tree and forest products in securing food (IMWI). In addition, it encourages the reuse of agricultural waste products, such as crop residue and by-products from processing, in animal feed, and the reduction of inputs that affect long-term sustainability. Better integration of biodiversity within the farm system can increase water infiltration and storage as well as the presence of pollinators.

To facilitate this there will need to be *transitions in institutions* and the roles and relationships of different sectors. Historically environmental agencies within governments have been weak relative to ministries responsible for trade, finance, and development. In many countries, environmental agencies simply function as a (weak) check on development choices through for example environmental impact assessment processes. Given the growing understanding that the stability and security of development initiatives, including for food security, are rooted in ecosystems, those agencies responsible for the environment need to be given a more fundamental and central role in defining strategies for achieving food security.

Many of the challenges related to food security are the result of *how tradeoffs are made* including the weak factoring in for costs on ecosystems. Moving towards an approach that looks at the food context as being a series of interlinked ecosystems is an important first step in understanding long-term and short-term gains and avoiding undermining ecosystem services that are critical for development, human well-being and resilience. This will demand better attention to the ecosystem dimensions within macro-economic policies, such as subsidies and biofuel mandates, to avoid negative impacts at the local level, include on land access (critical for food production) and food prices escalations (which affects access particularly for the urban poor). Strengthening local institutions as well as social learning processes can encourage attention to a broader range of considerations. In addition strengthening organization can empower local people to more effectively engage in making trade-offs.

Developing policies to encourage the uptake of system-based approaches that recognize the centrality of ecosystems to food security and that recognize the link between different sectors is essential.

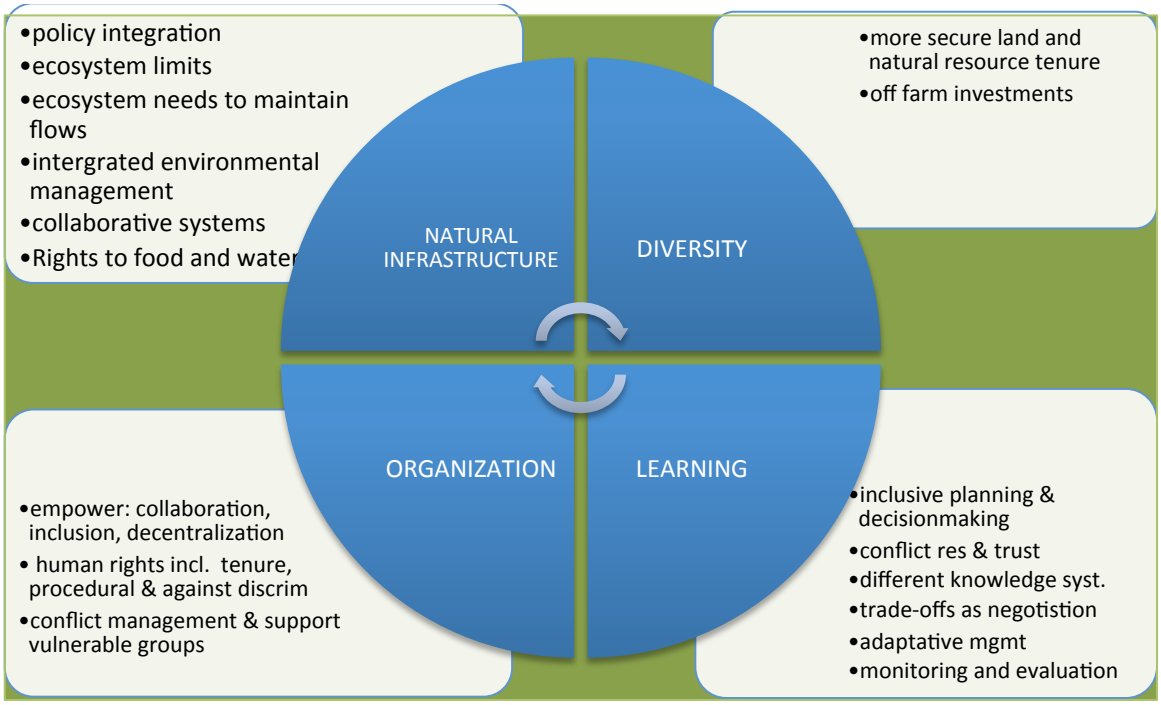
5.2. Policy Transitions are needed

Transforming food policy and practice so that it pays more focused attention to ecosystems makes good sense. As discussed this can support improvements in food availability, access and utilization as well as in the maintenance of stability – and ensure that food strategies are in harmony with the wellbeing of our biosphere. In addition attention to biological diversity, natural infrastructure, organization and governance, as well as to social learning (as discussed) has the additional benefit of increasing social-ecological resilience thus bolstering climate change adaptation and reducing the vulnerabilities of the poorest people. This effectively complements and augments the conventional focus on productivity and macro-economic issues.

Several key elements for such a transition can be identified. These speak to strengthening the resilience dimensions discussed and thus provide an opportunity to breakout of existing traps and to

enhance the capacity to find solutions to diverse and multiple food security challenges (Figure 3). While several of these policy interventions are crosscutting we have clustered them here according to the primary resilience dimension that they strengthen. The include policies to:

Figure 3: Strategic focuses to build food resilience



Strengthen Natural Infrastructure through**:**

- *The better integration of environment with other policies* related to improving food security including for climate adaptation and disaster risk reduction as well as with other policies that impact on the ecosystem services that underpin food security. This includes trade, energy, water and tourism policies. This will require creating better inter-sectoral linkages in institutions for policymaking, planning and practice. Creating a more central role for environmental agencies in development decision-making can help achieve this. In addition environmental agencies should guide how ecosystem services are addressed in food security policy and planning. Given that watersheds and land and seascapes provide the context for food security as well as other development related focuses such as energy, environmental agencies could play a central role in promoting and facilitating better cooperation among other sectors to improve sustainability and productivity of food systems. This could for example include support for efforts to reduce adverse impacts on freshwater and coastal ecosystems by reducing waste and negative externalities.
- *The recognition that ecosystems particularly freshwater and marine systems don't have limitless capacity to absorb waste.* This requires, among other things, adopting policies that reduce both point and non-point pollution. Reducing pollution can help support ecosystem health, the recovery of fish stocks and improve human health. For example, treating municipal and industrial wastewater is achievable with existing technology, but requires better regulatory oversight, infrastructure investment and capacity building, especially in developing countries.
- *Integrated ecosystem management* including better land-water management that recognizes the importance of conservation and development outcomes. Policies that build inter-sector links

and collaboration, include the full diversity of stakeholders in policymaking, increase investment in natural and human-made infrastructure, capacity building and regulation are needed to achieve win-win across development sectors and food security.

- *Collaborative systems – that cut across levels and boundaries including transboundary – for more effective resource management.* This includes establishing land and marine management regimes that transcend political boundaries and takes into account the ecological features and processes that will help achieve the long-term sustainability of living resources. In addition, given the centrality of water to food security, and expected changes in supply from climate change and in demand as population grows improving equity in use and sharing of international watercourses, that takes into account interests of local users and ecosystem functioning. Currently about 158 of the 263 international freshwater basins still lack cooperative management frameworks (GEO-5) making this a priority for securing natural infrastructure
- *The recognition of ecosystem water needs to sustain essential infrastructure and flows for food production.* In the first instance, this requires placing limits on allocation systems**.** Better data as well as monitoring, evaluation and feed back systems are needed to ensure that agreed allocations are appropriate and respected. Better implementation of international commitments and the enforcement of legally binding agreements, recognition of local use including customary use, improved dam management are needed to ensure equity and avoid conflict while maintaining flow.
- *Commitment to respect, protect and fulfil*[12] *rights to food and water.* A key step in this direction could include using these rights as thresholds for decisionmaking. This draws attention to the significance of natural infrastructure for realizing basic but fundamental rights and discourages disruption where it would have an adverse impact on food security.

Build Diversity through:

- *More secure land tenure and natural resource access.* Including the recognition of local tenure rights, including of indigenous people and women, in national policy and legislative frameworks can (1) makes land-use changes (biofuels, agriculture, conservation and development) subject to rights assessments (especially for food and water) and (2) encourage long-term investments in essential livelihood resources including biological diversity. A first step in this direction is to implement the *Guidelines on Tenure* to protect local livelihoods and food security.
- *Increased investment in off-farm environmental assets to strengthen resilience of smallholder farmers and pastoralists and to support diversified livelihood options.* Both national governments and international donors need to increase investments in environmental resources and ecosystems to ensure the availability of alternative (to agriculture) income sources. This will reduce vulnerable to extreme weather events and price shocks. Ensuring local people are able to use these opportunities requires financing, supporting knowledge exchange and learning, and encouraging robust and effective local organization.

Invest in building robust local organizations through:

[12] Respecting rights means refraining from interfering with the pursuit or enjoyment of rights. Protecting rights means ensuring that third parties (including businesses and non-governmental organisations) do not interfere with the pursuit or enjoyment of rights. Fulfilling rights means creating enabling environments for the realisation of rights. Rights need to be provided where people cannot provide for themselves, but can be fulfilled progressively inline with available resources (Campese 2009)

- *Empowerment of local actors as decision makers* including through decentralization. This will depend on investments in capacity, support for social learning, collaboration and inclusion, and authority for management. This could encourage more creative yet fair, flexible and just solutions that recognize local priorities.
- *The development of legal systems to respecting and protect human rights, including to food and water, and undertake concrete initiatives to fulfill these rights. This* creates basis for effective organization as human wellbeing (good health, access to material goods, good social relations and personal security) are the foundation of human capacity to act (Sen 1999, Jaeger et al 2007)
- *The strengthening of procedural rights within national law* to empower local communities as effective actors in achieving their food security and to claim substantive rights, such as land rights. These rights serve as a basis for local people to claim their rights including to food and water and demand accountability of governments. Substantive rights will remain unmet unless rights such as those articulated in Principle 10 of the Rio Declaration are in place. The gains made by indigenous peoples in the Americas have come, in part, through access to justice, often at an international level. Participation in development projects has led in some cases to better design, including changes in laws to enable community forest management.
- *Acknowledgment of good social relations are a key constituent of human wellbeing and the ability of people to make choices that support their priorities and thus achieving these must be a policy priority*. This requires addressing inequity and inequality, including discrimination**.** And it sets the basis for reducing conflict when equitable access to resources, and the information, infrastructure and other supports is ensured.
- *Removing discrimination against women* through formal recognition of equality and specific changes in areas that impact on their food security and productivity. This includes adopting measures to recognize and protect their title to land and natural resources, improving access to agricultural support services and credit.
- *Enhancing the opportunities for small-scale food producers* (farmers and pastoralist) requires policies that enhance capacity including by removing subsidies and other market-distorting trade policies (IFAD 2012).
- *Adopting climate-sensitive policies that compensate for the financial and social loss* associated with floods and droughts

Facilitate learning through:

- *Inclusive planning and decision-making system that focus on learning***.** This requires opening up policy processes to more diverse forms of knowledge, a variety of actors, and embracing participatory or collaborative approaches. Institutional change that requires "citizen inclusion and deliberation" would include, for example, a right to be heard and to be given reasons for any decision reached. Additionally citizens need to be able to contest decisions made.
- *Recognize the legitimacy of a variety of systems of knowledge, and to give them all a place in the decision and policy-making process* (IIED 2011). The issue here is not to choose between popular knowledge and scientific expertise, but to encourage exchange.
- *Increased invests in conflict management.* This will require policy change that helps communities transcending mistrust and achieving the grounds for sharing and learning, and negotiation and joint problem solving. These changes can include removing and reducing structural discrimination including against indigenous people and women, recognizing local value systems in allocating benefits. Further mutual respect and dialogue among actors will be needed to move

from conflict to collaboration. In the environmental sector management processes that include a broad range of actors have helped encourage an exit from violence, including in the management of water (Conca and Dabelko 2002) and biodiversity (Hamill). This helps encourage support for decisions for difficult tradeoffs that may in the short-term have disadvantages at the local level. In addition increasing fairness and justice through better access to justice, transparency in government appointments, and the removal of discriminatory practice can reinforce these gains (World Bank 2012/World Development Report conflict).

- *Recognition of trade-offs as more than just a technical process but a social one.* This requires recognizing the importance of local priorities, values and knowledge in decisionmaking. Linking the capacity needed for negotiation and collaboration. Recognizing human rights along with planetary boundaries as a limitation on development will be key to ensure food insecurity and vulnerability is not increased.
- *Seeing management and conservation as adaptive and flexible*, this reinforces learning and reflection on existing experience.
- *Developing monitoring, evaluation and feedback mechanisms* to establish the effectiveness of policy and to feed these understandings back to diverse actors.

5.3 Conclusion

Feeding this and future generations will given the growing environmental pressures associated with climate change, poor environmental governance and management, rising demand from population growth, changing diets and increasing financial wealth demand that we find new ways to safeguard these fundamental resources. New levels of uncertainty and extreme events under climate change makes incorporating the ecosystem dimension in food security strategies critical to building resilience – curtailing climate change and enhancing adaptive capacity through greater equity and ecosystem restoration. This will demand take a fresh look at farms and how to use ecosystems to enhance productivity as well as looking beyond the farm. The environmental context in which people live is not some abstract collection of goods and services, but constitute the "stuff" from which people build their livelihoods, create new opportunities and respond to change. It is this vitality that lies within ecosystems that must be seized not to replace agriculture but to augment it.

As existing policy shows this must include reducing local vulnerability by addressing the underlying drivers of insecurity. In the proceeding sections we have shown that ecosystems deterioration is significant and forms a mesh with other drivers such as poverty and conflict to reduce the productivity of natural, managed and cultivated food systems. Each dimension of food security – availability, access, utilization and stability – can receive a boost by focus on those system components that enhance coping capacity and the capacity to respond effectively to new circumstances through rebuilding and redesigning. These dimensions are both social and ecological and focus on the key constituent parts of each: natural infrastructure, diversity, organization and learning. This understanding contradicts the assumption that environmental concerns are secondary to productivity priorities. Instead they are part of one system.

Building good social relations will be critical – this will require greater attention to equity, justice and fairness dimensions within food policy. It is morally and ethically unacceptable where so many lack the opportunity to live free from hunger.

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