
A strategic framework for environmental and sustainable development in Nepal

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Abstract: Using the framework of Asta-Ja, meaning eight ‘Ja’ – Nepali letter ‘Ja’, Jal (water), Jamin (land), Jungle (forest), Jadibuti (medicinal and aromatic plants), Jansakti (manpower), Janawar (animals), Jarajuri (plants) and Jalabayu (climate) in Nepal, this paper assesses challenges and constraints, and presents a strategic framework for environmental and sustainable development in Nepal. Also, this paper underscores the need for the convergence and mutual reinforcement of environmental and economic policies for sustainable development, and emphasises the importance of system-based, participatory, interdisciplinary and holistic approaches in using the Asta-Ja framework to achieve sustainable long-term development in Nepal. By avoiding the need to retrofit and correct short-sighted developmental projects when environmental problems arise, the Asta-Ja framework will optimise environmental, social and financial benefits.

Keywords: Asta-Ja; sustainable development; environmental resources; Nepal; strategies.

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1 Introduction

Evidence suggests that from the beginning of their existence, human beings had been living in harmony with nature until they invented farming. With the advent of agriculture, humans began to meet their basic needs in more exploitive ways, which has been expanded exponentially since the scientific age. The former ‘balance’ has now shifted

towards environmental destruction, climate change and related hazards, and ecological degradation (Carson, 1962; Leopold, 1970; Malkina-Pykh and Pykh, 2003; McBean and Ajibade, 2009; Poudel et al., 1998; WCED, 1987). Scientific agriculture that began roughly in 1600 AD is largely characterised by unsustainable practices such as monoculture, intensification and indiscriminate application of a large number of dangerous chemicals. Although global food production has increased due to scientific agriculture, its negative impacts such as soil erosion and depletion of topsoil, environmental pollution, groundwater contamination, decline in biological diversity and environmental degradation are a matter of great concern (Cunningham and Cunningham, 2010; Poudel et al., 1998; Shrestha and Clements, 2003; WCED, 1987). The discovery of an 'ozone hole' over Antarctica in 1985 (Farman et al., 1985) is another serious global environmental concern of modern days. Similarly, over-harvesting of forest products and ocean fisheries, deforestation, acidification, water pollution, air pollution, emissions of greenhouse gases (GHGs), increasing amounts of hazardous wastes, solid wastes, toxic substances in the environment, climate change and vulnerabilities, sea level rise, and loss of species (IPCC, 2007; Malkina-Pykh and Pykh, 2003; Nadakavukaren, 1990; Schild, 2009; UNDP, 2007) are other significant global environmental concerns threatening ecological processes and environmental sustainability of the planet earth.

While many governmental and non-governmental organisations, international agencies, community organisations, the general public and other stakeholders have actively contributed to addressing the current environmental issues and the future risks at various levels and capacities worldwide, the leading role of the United Nations in addressing environmental challenges is notable and commendable. Some of the major initiatives taken by the United Nations in this regard can be summarised as the Stockholm Declaration and Action Plan which focused on 'industrialised' environmental problems, such as habitat degradation, toxicity, and acid rain, and emphasised the need of developmental strategies for poor countries (UNEP, 1972), the setting up of the United Nations Environment Programme (UNEP) following the 1972 conference, setting up the World Commission on Environment and Development (WCED) in the 1980s, the publication of *Our Common Future* in 1987 (WCED, 1987); and hosting the 'Earth Summit' in 1992 (UNCED, 1992), the World Summit on Sustainable Development in 2002 (WSSD, 2002) and the United Nations Climate Change Conference in Copenhagen in 2009. While showing full commitment to Agenda 21, the World Summit on Sustainable Development in 2002 avowed the UN's Millennium Development Goals (MDGs) of addressing extreme poverty, hunger, disease, gender inequality and exclusion, education, shelter, environmental sustainability and global partnerships by 2015. The adoption of Kyoto Protocol in 1997 and its enforcement in February 2005 was another milestone on reducing GHG emissions and fighting against global climate change.

Despite many environmental and sustainable development initiatives, results on poverty alleviation, environmental resources conservation, and improvement of economic and health conditions for people, especially in developing countries, are far from being satisfactory. As most developing countries are predisposed to natural resource-based economic development, which often begins with over-utilisation of natural resources and environmental pollution, it is important for a developing country to formulate economic developmental strategies and environmental plans that enhance environmental conservation and expedite sustainable economic development (WCED, 1987). If the sustainable development of a nation is to be achieved, it is absolutely necessary that there

be a synergistic relationship between the environmental development plan and the economic development plan.

Nepal's vast water resources include over 6,000 rivers and streams, hundreds of snow peaks and lakes, 3,252 glaciers, and 2,323 glacial lakes (Bhandari, 2002; Shrestha and Hisaki, 2007) and groundwater resources. These vast water resources present Nepal with a total theoretical hydro-electric potential of 83,290 MW, of which a generation of 42,110 MW of hydro-electricity is economically feasible (Kafle, 2008). The total land area of 14,748,000 ha in Nepal (LRMP, 1986) consists of a spectacular landscape stretched from east to west, including three broad physiographic zones. North to south are the mountains, hills, and terai, respectively, containing 35%, 42% and 23% of the total area, and 7%, 46% and 47% of the population (Maltsoglou and Taniguchi, 2004). Table 1 below shows the cultivated area and production of major agricultural crops in 2005/2006 in Nepal. Livestock population in 2003/2004 consisted of 6.96 million cattle (including yaks and hybrids), 3.95 million water buffalo, 0.82 million sheep and 6.98 million goats (Pariyar, 2006). Various wild animals including elephants, rhinos, tigers, lions, crocodiles, deer, monkeys, snakes, egrets, herons, parrots and white-tailed robins can be seen in Nepal. In 2005, Nepal's forests consisted of 3,636,000 ha which is 25.4% of land area, and other wooded areas consisted of 1,897,000 ha (FAO, 2005). In the Nepalese forests, there exists an appreciable number of plant species which are identified as medicinal and aromatic plants possessing high commercial value. The climatic differences from north (tundra) to south (tropical) has greatly influenced biodiversity, forest types, wild animals, water resources, soils, ecology and agricultural production. In 2007, the estimated population of Nepal was 26,427,399 (CBS, 2007). Even with such a vast natural resource base, Nepal's progress in economic development is far from satisfactory. To utilise the vast natural resources for sustainable economic development, there is an urgent need for a theoretically grounded framework for environmental and sustainable development in Nepal.

Table 1 Estimated total cultivated area and total production of major agricultural crops in 2005/2006 in Nepal

<i>Crops</i>	<i>Cultivated area (000 ha)</i>	<i>Production (Mt)</i>
Paddy	1,549	4,209
Maize	850	1,734
Wheat	672	1,394
Barley	26	27
Millet	261	290
Sugarcane	62	2,462
Oil seed	188	139
Tobacco	2.7	2.7
Potato	150	1,974

Source: CBS (2007).

2 The Asta-Ja framework

With a view for conservation of environmental resources and sustainable economic development of Nepal, I have proposed a theoretical framework based on sustainable development and management of Eight 'Ja' – Nepali letter 'Ja', *Jal* (water), *Jamin* (land), *Jungle* (forest), *Jadibuti* (medicinal and aromatic plants), *Jansakti* (manpower), *Janawar* (animals), *Jarajuri* (plants) and *Jalabayu* (climate) referred to as Asta-Ja in the Nepali language (Poudel, 2008). By recognising the potentials of the Eight 'Ja' for economic transformation of Nepal, the Asta-Ja framework has established interrelationships and linkages among and between the Eight 'Ja', and has emphasised a system-based, participatory, interdisciplinary and holistic approach to resource management and development. The Asta-Ja framework also emphasises the formulation of national policies based on ground realities, public involvement, competitive advantages, global considerations, and environmental and economic priorities.

Sections 3 and 4 identify challenges and constraints and formulate strategies for environmental and sustainable development using the Asta-Ja framework in Nepal.

3 Challenges and constraints

According to ADB (1999), among many others, physical and economic constraints, high transportation costs and low workforce skills are the major constraints to development in Nepal. Further insight into the challenges and constraints to sustainable economic and environmental development in Nepal can be achieved by identifying challenges and constraints associated with specific Asta-Ja resources. For instance, challenges to harnessing water resources in Nepal include highly rugged and steep topography, fragile geology, monsoon climate and floods, soil erosion, and sedimentation and landslides. With urban areas facing serious water shortage because of rural-urban migration, population growth and unplanned urbanisation, there is a growing problem of surface and groundwater pollution (ADB/ICIMOD, 2006). Arsenic contamination in ground water has been reported in several Terai areas (Neku and Tandukar, 2003; Pokhrel et al., 2009). Controlling water pollution in lakes, reservoirs and streams is a major challenge. Overdraft of groundwater use has resulted in many unwanted environmental problems including subsidence, declining water quality, depletion of ground water level and increased pumping costs. Global climate change, snow melts, glacier outburst and flooding are other problems that affect the sustainability of water resources in Nepal. In terms of land resources, soil erosion, land degradation, declining land productivity (ADB/ICIMOD, 2006), conversion of marginal land and steep slope land to agriculture, excessive land fragmentation and stream bank erosion can be listed as major challenges. Land abandonment due to land degradation, soil pollution or any other causes would result in economic loss. Nepal is also enriched with many minerals and mines such as limestone, iron, copper, slate, marble, lead, nickel, pyrite and gold (Bhandari, 2002; Kuo, 1998). Use of better surveying techniques, application of cost-effective improved mining technologies, environmental considerations in mining, and better processing and marketing of mines and minerals are significant challenges. Appropriate infrastructure for tourism development is necessary to maintain and preserve wilderness, ensure peace and security, and sustain cleanliness and a healthy environment for tourism development.

Although Nepal's forest sector holds vast potential for future economic transformation, critical information necessary for sustainable forest resource use such as periodic national forest inventory, forest growth, yield, system of calculating annual allowable cut to estimate annual income from forestry, and sustainable forest management and development strategies is seriously lacking. Further formulation of appropriate forest laws and regulations and their adequate implementation are important challenges for forest conservation and sustainable development in Nepal. Nepal's forests are currently suffering from depletion, degradation, encroachment, deforestation, decline in biodiversity, over-harvesting of forest products and habitat loss. Indigenous to Nepal's forest are an appreciable number of plant species that have been identified and recorded as medicinal and aromatic plants. Some of the major medicinal and aromatic plants traded in and from Nepal include *Aconitum spicatum* (Bish), *Bergenia spp.* (Pakhanbed), *Epimerantha macraei* (Jiwanti), *Nardostachys grandiflora* (Jatamansi), *Neopicrorhiza scrophulariiflora* (Kutki), *Rheum australe* (Padamchal Amalbed), Silajeet (Olsen and Larsen, 2003), *Cordyceps sinensis* (Yarsagumba) (Devkota, 2006), *Dactylorhiza hatagirea* (Panchaule) and prickly ash (Timur). The export of medicinal and aromatic plant products is a trend that increases every year (Larsen, 2005; Olsen, 2005; Olsen and Larsen, 2003). Unsustainable collection methods, erratic supply and low quality produce, unreliable markets, lack of technical know-how, lack of appropriate policies, and the lack of research and development on medicinal and aromatic plants are some of the major issues and problems regarding *Jadibuti* resources in Nepal (Anil and Kerkhoff, 2004). Scientific understanding of plant ecology, plant physiology, agronomic practices, plant propagation techniques, diseases and pests, and environmental requirements of medicinal and aromatic plants presents another challenge for sustainable development of medicinal and aromatic plants resources in Nepal.

Fragmentation of responsibilities for agricultural development among various ministries and departments, the lack of coordination, chronic underfunding of the agricultural sector, lack of key inputs such as irrigation, fertilisers, and inadequate agricultural research and development are the major problems associated with agricultural development in Nepal (NPC, 2003). The specific challenges vary enormously with respect to each agricultural enterprise. For instance, Devkota (1999) identifies, among many others, inputs supply, marketing, finance, soil erosion, unfavourable conditions due to hailstorms, pests and diseases, lack of trained manpower, weak extension system, and fragmented and small land holdings as major constraints to deciduous fruit production in Nepal. Certainly, the development of high-yielding, disease-resistant and drought-tolerant plant varieties; the development of integrated pest management (IPM) technologies, adoption of sustainable harvesting and processing techniques, and the development of adequate storage facilities are extremely important for increased agricultural production. The conservation of agricultural crop diversity; however, as well as the improvement in integrated farming, needs immediate attention for the enhancement of agricultural sustainability in Nepal. Meanwhile, poor quality and insufficient forage and feed supplies, lack of marketing infrastructures and chilling centres, lack of animal products processing facilities, insufficient livestock research and development, and inadequate livestock monitoring activities are major constraints to livestock development in Nepal (ADB, 2003; Pariyar, 2006).

Nepal contains six different types of climate: tropical monsoon climate, subtropical monsoon climate, warm temperate monsoon climate, cool temperate climate, alpine climate and tundra or arctic climate (Bhandari, 2002). Global climate change has

adversely impacted the Himalayan region resulting in incidents of extreme rain events (Gaur, 2007), glaciers retreat, shorter winters, earlier snowmelt, natural hazards, altered river regimes, and interrupted water supply affecting people's livelihoods (Schild, 2007), landslides, avalanches and debris flows. Defining and implementing appropriate adaptive measures to cope with climate change/global warming is a major significant challenge for Nepal (Kenneweg, 2008; Schild and Banskota, 2008). Continued monitoring of glacial lakes and the development of mitigation measures for protecting infrastructures and human life are urgent. Within the six broad climatic zones in Nepal, there exists a great variety of micro-climatic conditions resulting in diversity of vegetation, wildlife, land use types and land management practices. These climatic and microclimatic conditions offer competitive advantages in year-round production of high value crops such as fruits and vegetables, cash crops, cut flowers, vegetable seeds, spice crops, livestock and other agro-based products which allows Nepal to export surplus agricultural produce to other countries during the off-season, fetching premium prices (Poudel, 2008). A clear understanding of climatic diversity, presence of microclimates and better utilisation of climatic diversity in agricultural production, housing improvement, tourism development, and environmental resources conservation and utilisation are important challenges for better utilisation of climatic diversity in achieving sustainable development in Nepal.

According to ADB/ICIMOD (2006), the economically active population in Nepal is below 50%, indicating the existence of a large number of dependent persons, and 66% of the total employed population is engaged in agriculture, forestry and fishery sectors. With a literacy rate of only 49% (2000–2005) (UNICEF, 2009), Nepal has a tremendous challenge of developing the skilled manpower needed for sustainable economic development. It is important for Nepal to develop a student-centred educational system, promote community awareness, generate employment, and ensure peace and security for economic progress and environmental sustainability at the local, regional and national level. In addition to developing educated manpower on conventional disciplines such as medicine, law, business, art, agriculture, forestry, science and engineering, manpower should also be educated in emerging fields of biotechnology, genetic engineering, information technology (IT), nano-technology, alternative energy and green technologies. Manpower can also be developed nationwide on eco-friendly jobs such as park manager, wildlife care taker, fire manager, certified timber producer, eco-tourism manager, soil and water conservationist, nature trail manager, and jobs related to medicinal plants, environmental sanitation, nutrition, education, beekeeping, water management, land rehabilitation and organic production. Alleviation of food deficit and poverty, as well as promotion of higher education that balances knowledge, skills and values is critical for the development of a sustainable society.

4 Strategies for sustainable development

The strategies for environmental and sustainable development in Nepal using the Asta-Ja framework are discussed below.

4.1 *Community awareness*

To identify existing community problems and courses of action, Paudyal (2009) proposes a checklist for community environmental awareness containing parameters such as health and nutrition, education, labour force, infrastructure, transportation, communications, marketing facilities, community institutions, energy use, risk management, farming, animal husbandry, forestry, natural resource utilisation and equity. Herremans and Reid (2002) demonstrated the use of sustainability triad proposed by Sadler (1990) in assessing the results of stakeholder processes and management strategies for land resource use in a Canadian national park. The sustainability triad includes three dimensions of sustainability: economic values, social values and environmental values, and the sustainability domain is the one in which an organisation can operate and maintain harmony among the three dimensions. Similarly, various environmental community awareness programmes aim for the effective mobilisation of village committees, hosting capacity building workshops, and conducting follow-ups, monitoring, assessments and evaluations. Some promote environmental awareness through education and community activities such as inter-school exchange programmes, agricultural and environmental challenge programmes, environmental training programmes for teachers, mobilisation of environmental clubs in schools, and clean-up and restoration activities (Poudel et al., 2005; NJITCEAG, 2005). Various community activities such as townhall meetings, community training, Asta-Ja group meetings, workshops, field days, Asta-Ja Clubs, *Jadibuti* demonstration plots, streambank erosion control, clean-up projects, reforestation activities, drinking water projects and animal care workshops may be undertaken for enhancing Asta-Ja awareness. News media such as radio, television, newsletters and newspapers should be utilised for Asta-Ja community awareness and sustainable development at the community level.

4.2 *Assessment of Asta-Ja*

A comprehensive assessment of Asta-Ja resources is a prerequisite for sustainable economic development and natural resources management in Nepal. While water resources may be assessed with respect to volume, discharge, flood frequency, water quality, reservoir capacity, seasonal variability, etc.; land resource may be assessed with respect to land use types, land capability and suitability, tourism potentials, mines and minerals, land holding size, land tenure, land fragmentation, land quality, land degradation and land rehabilitation. Similarly, forest resources may be assessed with respect to forest distribution, forest types, forest productivity, forest biomass, forest growth and sustainable forest resources. Medicinal and aromatic plants could be assessed with respect to their distribution, production, sustainable harvest, possible domestication, quantity of production and their market potential. Agricultural and horticultural crops can be assessed with respect to their productivity, genetic improvement, crop physiology, adaptability, cropping systems, resources requirement, agronomic practices, diseases and pests, and commercial values. Animal resources could be assessed with respect to their production potentials, genetic improvement, production management, commercial values, market opportunities, diseases and pests, and adaptability. Commercial production of agricultural crops and animals can be expedited through the establishment of production zones and the development of necessary infrastructures. An assessment of *Janasakti* (manpower) in terms of total manpower, skilled manpower, manpower distribution and

manpower availability is important for sustainable development in Nepal. As climate impacts water resources, land, forests, agricultural crops, medicinal and aromatic plants, animals, and human activities (Poudel, 2008), a clear understanding of different climate types, micro-climatic conditions and climate change on environmental and natural resources is important for sustainable development. Regular climatic monitoring and assessment are critical for the development of society's preparedness for natural disasters such as floods and droughts. There are various techniques and tools such as surveys, census data, remote sensing (RS), global positioning system (GPS), geographic information system (GIS), statistical models, mathematical equations, geostatistics and computer models which can be used in assessing Asta-Ja resources.

4.3 Asta-Ja database

Appropriate policy formulation, project development and decision making in resource development and management require extensive and up-to-date data on natural resources such as soil, land, plants, animals, crop production, water resources, forests, climate and bio-diversity. These datasets are in high demand by various researchers, scholars, engineers, scientists, modellers, economists, regulators, planners, consulting companies, decision makers and other users. For handling a large integrated dataset a database management system (DBMS) software which integrates and manipulates the logical structures in the data file is required (Bowers, 1988). The relational data model that utilises a common attribute in grouping data is widely used in various database applications related to natural resources. GIS is widely used in setting up environmental database of digital maps, satellite imageries, aerial photographs and digital elevation models (DEM). Statistical data on natural resources such as water quality, land resources, soil, forests, agricultural production, urban areas, floods and restoration activities can be easily linked with the spatial GIS datasets. In many cases, map scales, spatial and temporal variability in data generation, dataset quality and the format of available data become very problematic in developing an integrated GIS database. In addition to setting up DBMSs and GISs, there should be a good database management practice in which users are able to access the statistical dataset and GIS dataset through their web browsers and perform data analysis without the need for reformatting, downloading, etc. (Campbell, 2008). According to ADB/ICIMOD (2006), environmental and natural resources datasets in Nepal are very dispersed, heterogeneous, inaccessible, discontinuous, and often unreliable, and there is a need for establishment of an environmental and natural resources information network. Designing such an environmental and natural resources network using the Asta-Ja framework in data collection, data collation, archive, update and retrieval would enormously enhance the relevancy, usefulness and the power of the network in feeding environmental information to policy makers and effectively tackling the environmental and economic developmental problems in Nepal.

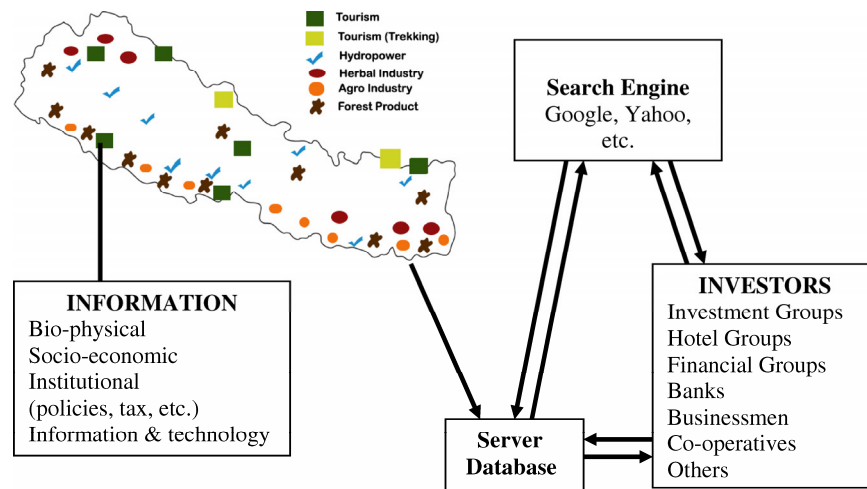
4.4 Economic analysis

The conventional cost-benefit analysis often becomes less preferable when assessing natural resources related projects in terms of their profitability. Non-monetary values that a society receives from the environmental projects are often much higher than the monetary values; for instance, improved water quality, improved soil types, improved air

quality and their cumulative impacts on the human environment. Similarly, conservation of plant species that might have significant, life-saving medicinal value in the future is priceless. Also, most natural resource projects have externalities such as negative impacts on the ecosystem, degradation of aesthetics in the landscape, and loss of land, forests, species, etc. Accounting for these costs is often difficult. Natural resource-based projects, therefore, should be evaluated considering monetary and non-monetary gains, and often environmental and societal benefits out of these projects may have to be considered for long-term sustainability, even if they are not economically feasible at present. For example, organic farming without premium prices is not economically viable in California, USA (Poudel et al., 2001); however, the environmental and societal benefits such as chemical-free products, farm safety, soil enrichment, carbon sequestration, improved infiltration and habitat preservation for other organisms certainly outweigh the conventional systems and enhance sustainability. Therefore, full consideration should be given to the non-monetary values of Asta-Ja projects while we evaluate them in terms of their economic viabilities. Economic analyses such as social accounting matrix (SAM) (Thorbecke, 1998), input–output analyses and forward/backward linkage analyses will help in prioritising the Asta-Ja-based developmental projects. A SAM is a disaggregated general equilibrium accounting framework and is developed to study the flows of economic transactions, expenditures and receipts. Once flows of economic activities are identified and analysed, it is important to do input/output analysis to understand inter-industry relations in an economy. Once the potential Asta-Ja-based developmental projects are identified through above analyses, forward linkages and backward linkages of these projects should be identified. Then, the priority ranking for Asta-Ja projects could be accomplished. Asta-Ja projects that are crucial for economic development in Nepal should be documented in the Asta-Ja Investment Information System (AJIIS) as discussed in Section 4.5.

4.5 Asta-Ja Investment Information System (AJIIS)

A highly interactive and user-friendly information system accessible to standard web browsers which presents potential Asta-Ja related projects such as tourism, hydropower, agro-industries, forest products, medicinal and aromatic plants-based industries, etc. should be designed and made available online. It is important to have a system that allows users to access, to analyse and to download easily any statistical, GIS, satellite imagery, aerial photos, GPS and other related information through web browsers. Availability of accurate information online in relation to bio-physical, socio-economic, institutional, informational and technological aspects of Asta-Ja investment projects would help potential investors to assess their investment portfolios and make quick decisions on such projects. While water resource projects may require information on hydrology, discharge, seasonality, water quality, aquifer systems and potentials for hydro-electricity development; agricultural projects may need information on land productivity, land availability, soil types, climate and production potentials. Similarly, a hotel project may require information on nearby tourism sites, walking trails, eco-tourism sites, etc. A forest-based industrial project may need information on forest types, forest inventory, potential for sustainable harvest, and logging rules and regulations. All of this information should be updated and made easily available to the users. Figure 1 shows a scheme for AJIIS in Nepal.

Figure 1 Asta-Ja Investment Information System (AJIIS) (see online version for colours)

4.6 Asta-Ja policies

As the relationships between environmental resources are complex and are interlinked, policy related to one resource must enhance sustainability of other resources as well (Poudel, 2008; WCED, 1987). For instance, agricultural policies for food security must increase soil quality, enhance conservation, improve biological conservation, and augment forest and water resources sustainability. Agricultural policies that are fragmented and depend on external technologies will never be self-reliant. Likewise policies oblivious to grass-root realities that lack community participation will not be successful. For example, because livestock constitute the primary source of cash income in rural Nepal, it is important to formulate agricultural policies targeting livestock production and marketing to ensure income generation and poverty alleviation especially in the rural areas (Maltsoglou and Taniguchi, 2004). Environmental resource policies such as surface water, ground water, waste disposal, clean air, land use, wild life habitat, food production, mining, tourism, forest conservation, biodiversity, medicinal and aromatic plants, animal resources, alternative energy resources, trade and institutional development are just a few of many Asta-Ja policies that are critical for environmental and sustainable development. For effectiveness, the environmental and natural resources policies must be compatible with the existing body of environmental and natural resources laws, such as those dealing with water quality, air quality, biodiversity, pesticides and hazardous chemicals, management of degraded lands, and trade (Salzman and Thompson, 2003). After that, the proper implementation of environmental and natural resources legislations becomes critical. Therefore, Nepal's government must be prepared to make sufficient investments on policy measures such as supply of agricultural inputs, information dissemination on IPM, inputs use, and efficient output marketing (Jansen et al., 1995), and developing and implementing legislation aimed at environmentally responsible and sustainable development. Economic policies and the environmental policies must converge and support each other in order to enhance the sustainable development of a nation. To avoid expensive retrofitting because of

environmental backlash and long-term concerns, developmental projects must undergo a rigorous environmental assessment process prior to their implementation. While formulating Asta-Ja policies, all stakeholders, communities, participating agencies, governmental institutions, the public, and those involved in the development and management of Asta-Ja and economic development of the nation must be directly and sufficiently engaged.

4.7 Sustainable systems, technologies and practices

Given the large number of agricultural crops produced across various agro-ecoregions and the fact that crop and livestock integrated production systems are a dominant agricultural practice in Nepal, it is important to understand Nepal's agriculture from systems perspective and adopt a holistic approach while designing cropping systems and formulating agricultural policies for meeting demands for food and energy (Shrestha and Clements, 2003). Since there is either stagnation, or only a marginal increase in the productivity of most agricultural crops, and in some crops even a decline in productivity over the past several years in Nepal (NPC, 2003, p.31), rapid increase in agricultural productivity through the implementation of environmentally sound technology and practices, biotechnology, precision farming, IPM technologies, energy saving technologies and conservation of environmental resources is urgent for meeting increasing demand for food, fibre and other products. Use of sustainable technologies and practices in harnessing environmental resources such as water, land, forests, plants, wind, solar, geo-thermal energy and biofuel are critical for environmental sustainability and long-term economic profitability. While many environmentally sound resource utilisation technologies and practices in a society can be found in its repository of indigenous technology knowledge (ITK), there is still a need for regular development of appropriate technologies and practices for environmental resource use and management.

4.8 Environmental institutions, trade and governance

Nepal is facing emerging environmental issues such as trade and environment, environmental governance, environmental finance, resource conflicts, institutional strengthening and capacity building (ADB/ICIMOD, 2006), and the effective tackling of these issues is critical for environmental and sustainable development. Institutional strengthening and development are important for the formulation of appropriate programmes and policies, implementation of environmental projects, enforcement of rules and regulations, trading, legislation, and regular updates on Asta-Ja database and Investment Information System. Although Nepal has promulgated various environmental resources acts in the past years, their implementation has not been satisfactory. For example, efforts are still needed to ensure sustainable development and management of common property resources such as community forests and scrubland, community pastures, village ponds, riparian areas, and rivers and streams that contribute significantly to livestock production and management in Nepal (Pariyar, 2006). Strict control on poaching, formulation of wildlife conservation rules and regulations that are widely supported by the common people, and education and research on wildlife conservation, biology and ecological integrity is necessary.

5 Conclusions

Nepal presents enormous multi-faceted challenges relating to the bio-physical, socio-economic, information and technology, and institutional system for environmental and sustainable development. These challenges, among many others, include alleviating poverty, ensuring food, water and energy security; generating employment, improving socio-economic conditions, enhancing environmental governance, and adequately conserving and managing environmental resources. To scientifically address these issues and challenges, Nepal needs a viable developmental framework that facilitates and enhances the formulation of appropriate economic and environmental policies that support each other and ensure their convergence. The Asta-Ja framework offers an opportunity for sustainable development of environmental and natural resources, and economic transformation of Nepal. Based on the framework of Asta-Ja, the Asta-Ja strategies: community awareness, Asta-Ja assessment, Asta-Ja database, economic analysis, the AJIIS, Asta-Ja policies; sustainable systems, technologies and practices; and environmental institutions, trade and governance, provide a theoretically grounded strategic framework for environmental and sustainable economic development in Nepal.

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