Asta-Ja Framework: A Peaceful Approach to Food, Water, Climate, and Environmental Security Coupled with Sustainable Economic Development and Social Inclusion in Nepal

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Abstract

Sustainable conservation, development, and utilization of natural and human resources is necessary for accelerated economic growth and fast-paced socio-economic transformation of Nepal. Asta-Ja Framework, which is a theoretically grounded grassroots based peaceful and self-reliant planning and development approach, offers practical strategies for sustainable conservation and development of natural and human resources enhancing food, water, climate, and environmental security, accelerated economic growth, and socio-economic transformation of Nepal. Asta-Ja includes interconnected eight resources in Nepali letter, *Ja,* – *Jal* (water), *Jamin* (land), *Jungle* (forest), *Jadibuti* (medicinal and aromatic plants), *Janashakti* (manpower), *Janawar* (animal), *Jarajuri* (crop plants) and *Jalabayu* (climate). Asta-Ja Framework is a unifying framework for planning and resources development and has a strong footing on science, business, and eastern philosophy. While providing practical guidelines for achieving food, water, climate and

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environmental security, this article presents Nepal Vision 2040, which is developed considering challenges that Nepal is currently facing and its available Asta-Ja resources, envisioning that Nepal's economic development reaching at the par of developed nations by 2040. Key strategic sectors identified in Nepal Vision 2040 include smallholder mixed-farming system, agro-*jadibuti* industrialization, protection of drinking water sources, climate change adaptation, environmental pollution control, conservation of natural resources, infrastructure, tourism, renewable energy, alleviation of inequalities, and good governance. This article demonstrates strategies for addressing social discrimination and inequalities through the process of Asta-Ja community capacity-building and self-reliant development. Ecological balance of Asta-Ja resources is necessary for sustainable natural resources, economic development, and community resiliency. The Government of Nepal is suggested to adopt Asta-Ja Framework as its national planning and development framework for sustainable economic growth and fast-paced socio-economic transformation of the country.

Keywords: Asta-Ja, food and water security, climate and environmental security, economic development, Nepal Vision 2040, social inclusion, Nepal.

Introduction

Nepal is an agricultural country. Almost 68% of Nepal's nearly 29 million people depend on agriculture for livelihoods (Poudel, 2015). Nepalese agriculture contributes about 33% to national GDP. Of the total surface area of 147,181 km^2, 28.7% include agricultural land. The Terai, Hills, and Mountain regions contain, respectively, 70%, 26% and 4% of total agricultural land with corresponding 50.3%, 43.0%, and 6.7% of total population (Poudel, 2015; Poudel, 2019a). Nepalese agriculture, which evolved over the millennia, largely consists of small scale family farms practicing mixed-farming system for meeting household needs of food supply (Poudel, 1991; Poudel, 2015). Along with a high level of commitment, perseverance and dedication, the operation of a family farm requires substantial knowledge and skills in crop production, livestock raising, resource management, and community engagement from a family. These family farms produce wide range of items including cereals, fruits and vegetables, spice crops, ornamental plants, fodder trees, livestock, poultry, and other farm products. Diverse agro-ecological zones, altitudinal gradients from Terai to High Himalayan region, year-round rainfall, conducive temperatures and favorable soil and

other agricultural production conditions make Nepal uniquely competitive for agricultural industries including commercialized vegetable production (Jansen et al., 1995; Midmore and Poudel, 1996) and agro-industrialization.

Highly picturesque landscape of Nepal mesmerizes the world. Nepal's elevation above sea level ranges from 60 meters in Terai to 8,848 meters at the top of Mt. Everest (Shrestha, 2007). With an average east-west length of 885 km and the north south breadth ranging from 145 to 241 km, Nepal contains five physiographic regions from south to north: Terai (60 – 300 masl), Siwalik Hills (120 – 1,800 masl), Middle Mountains (500 – 2,750 masl), High Mountains (1,970 – 4,500 masl), and High Himalaya (4,500 – 8,848 masl). Climatic zones extend from tropical climate in the lower lands of Terai to sub-tropical in middle hills and valleys, temperate in mountains, alpine in Himalayan region, and tundra or arctic climate in high altitudes. The vast and enthralling landscapes with snowy Himalayas, Blue Mountains, green forests, hills, valleys, flat lands, countless rivers and streams, lakes, and wildlife together with Nepalese cultures, arts, architects and its people make Nepal one of the major tourist destinations of the world. Additionally, Nepal is a holy land for Hindus and Buddhists. In ancient time, this land was known as *Satyabati* and was a *Devasthal*, the abode of God Shiva and Parvati in Hinduism (Poudel, 2020). Later this land turned into the land for meditation and *Yagna* (sacred Hindu fire ritual) and the land for salvation. Nepal is the land of vast Hindu deities and gods and nature's worships. Legendary King Janak, the father of Goddess Sita, ruled in current Jankpur, and Lord Budha was born in Lumbini of Nepal. This land served as the destinations and the place of enlightenments for many *Rishis, Maharshis* and other Hindu scholars in the past. There are large number of pilgrimage sites and holy places in the country that attract not only the followers of Hinduism and Budhism but also people from any other religions from all over the world. In addition to the development of infrastructure for conventional and ecotourism tourism across the country, Nepal needs to focus on the development of tourism sites that are linked with the spirit of Hinduism and Budhism, building professionalism in tourism industry, diversifying and extending the tourism experience, improving on tourism marketing and establishing global travel partnerships for sustainable tourism development in the country (Adhikari, 2020; Nepal, 2020; and Neupane, 2020).

A frequently cited theoretical hydropower potential of Nepal is 83,290 MW, with an economically feasible hydro-electricity generation of 42,110 MW (Kafle, 2008). Nepal can potentially export over 40,000 MW of hydro-electricity to other countries. Nepal has over 6,000 rivers and streams,

3,252 glaciers, 2,323 glacial lakes, many snow peaks, lakes (Bhandari, 2002; Shrestha and Hisaki, 2007) and groundwater resource. The Saptakoshi, Saptagandaki and Karnali are among the rivers of the first order, while some of the major rivers of the second order include Mahakali, Babai, Rapti, Tinau, Bagmati, Kamala, Kankai, and Mechi. As there is an increasing demand for bottled water in many countries including India, China, Taiwan, South Korea, Japan, and the gulf countries, due in part to scarcity of drinking water and pollution (Poudel, 2008), Nepal can earn substantial foreign exchange by simply harnessing drinking water from its pristine water sources that originate from the Himalayas and supplying drinking water to foreign countries.

Although Nepal occupies just 0.1% of the world's total land mass, it contains a large number of plant species (Poudel, 2008; Poudel 2019c). According to Bhuju et al. (2007), total number of flowering plant species recorded from Nepal in 2006 was 6,391 (2.76% of global totals), with 339 flowering plant species endemic to Nepal. Out of these recorded plant species, a large number of plant species are identified as medicinal and aromatic plants. Nepal has also been trading appreciable amount of medicinal and aromatic plant products (Olsen, 2005a; 2005b). Major medicinal and aromatic plants found in Nepal include *Aconitum heterophyllum* (Atis), *Aconitum spicatum* (Bish), *Bergenia spp.* (Pakhanbed), *Dioscorea deltoidea* (Bhyakur), *Epimerantha macraei* (Jiwanti), *Morchella spp.* (Gucchi chyau), *Nardostachys grandiflora* (Jatamansi), *Neopicrorhiza scrophulariiflora* (Kutki), *Rheum australe* (Padamchal Amalbed), Silajeet and *Cordyceps sinensis* (Yarsagumba) (Olsen and Larsen, 2003; Devkota, 2006). Additionally, *Dactylorhiza hatagirea* (Panchaule), prickly ash (Timur), swertia (Chiraito), *Malabar nut* (Asuro), jimbu, rudrachhe, cardamom, *Ocimum sanctum* (Tulsi), rauvolfia root (sarpagandga), *Picrocarpus santalinus* Linn (Ractachandan), *Taxus baccata* (Lothsalla), tejpat (Indian bay leaf), *Butea frondasa* (Amala), and *Acacia catechu* (Khair) are commonly utilized medicinal and aromatic plants in Nepal (Olsen, 2005a, 2005b). It is believed that there are many more medicinal and aromatic plants in Nepalese forests which are yet to be identified and recorded (Poudel, 2019c).

Nepal is the repository of vast traditional knowledge and skills. Substantial traditional knowledge exists in agriculture, handicrafts, metallurgy, iron works, paintings, arts, architect, animal care, medicinal and aromatic plants, and many other areas related to natural resources conservation and development and art of living. Aayurvedic medicine can be taken as an example of traditional knowledge that constitute the world's oldest medical system which combines largely herbal medicines, exercises, and life style changes

when treating diseases. Statue and idols making, woolen clothes weaving, *Dhaka* clothes, carpets, leather works, windows and wooden carving, and temple construction are some of the unique traditional knowledge and skills that Nepalese society possess. Nepalese are also known as great warriors. Nepal Army has been serving UN peace operations since 1958. Nepalese society is enriched with vast folklores, music, arts, and culture. Community practices of worshiping water bodies, forests, land, mountains, Himalayas, and other natural forces help conserve natural resources and protect from environmental pollution. Traditional knowledge and practices keep very high importance in sustainable management and utilization of natural resources.

Nepal is uniquely located in the world map. Based on land area, Nepal's northern neighbor China is the third largest country and its southern neighbor India is the seventh largest country in the world. Nepal is the 95th largest country in the world. In terms of population, China and India are the first and the second most populated countries in the world, with a corresponding population of 1,397,897,720 and 1,339,330,514, respectively (Poudel, 2019b, 2020; United States Census Bureau, 2021). China and India share 18.47% and 17.70% of the world's population, respectively. With its total population 29,136,808, Nepal is the 49th most populated country in the world and shares 0.37% of the global population (Poudel, 2020). Three sides of Nepal are bordered by India while one side borders China. This unique positioning renders a great opportunity for Nepal in relation to trade, technology transfer, and international relations (Poudel, 2019c).

Despite so many opportunities and possibilities for agricultural and economic development, Nepal is seriously struggling for food security, malnutrition, employment generation, and trade balance (Poudel, 2018a, 2018b). In 2014/15, Nepal had a negative trade balance of Rs. 622.37 billion (of which 63.22% was with India and 14.21% was with China), and two top imports in 2014/15 included agricultural products (Rs. 137.12 billion) and petroleum products (Rs. 112.16 billion) (CBS, 2016). In agricultural imports, rice and paddy constituted Rs. 23.79 billion (684,130 MT) and maize Rs. 7.43 billion (290.993 MT), with more than 95% of rice and paddy and maize coming from India. Other agricultural products imported in 2014/15 included fat and edible oil (Rs. 22.51 billion), vegetables (Rs. 15.93 billion), fruits and nuts (Rs. 10.54 billion), animal fodder (10.02 billion), oil seeds (9.11 billion), coffee, tea and spices (Rs. 4.27 billion), and sugar and confectionary (Rs. 3.49 billion) (Poudel, 2019b). During the same period, Nepal imported live animal worth Rs. 2.42 billion, dairy products Rs.2.15 billion, and fish Rs. 1.15 billion. Nepal's import of agricultural goods was more than US $2

billion (exact value in Nepalese rupees of Rs 215.50 billion) in the 2017-2018 fiscal year (Prasain, 2018). Nepal's food import reached Rs. 243 billion in fiscal year 2019/2020 (Kumar, 2020). In Nepal, 25% population is below the poverty line, 36% of children are suffering from stunting, 10% from mass wasting, and 53% from anemia (NDHS, 2011). Similarly, 41% of women of reproductive age are suffering from anemia and 17% are suffering from long-term energy deficiencies. Nepal is struggling with the historic unemployment challenges as more than 1,500 youths leave the country for foreign jobs every day (Poudel, 2019b). Almost seven million youths are in foreign jobs in more than 100 countries. There are nearly 400,000 Nepalese students in foreign countries. Most tragic situation is when dead bodies of Nepalese workers return in boxes from foreign countries. On average, 680 Nepalese working in foreign countries die every year. More than 7,500 Nepalese have died in foreign countries in the past eleven years. Nepal's two third of the total population is below the age of 30, and nearly 512,000 youths enter into the job market every year. In Nepal, almost 90% of total jobs are associated with informal sector such as agriculture, self-employed workers, household workers, and wageworkers, which lack the legal and the regulatory basis of the employment. Nepal's outstanding public debt has been increasing fast in recent years. Total outstanding debt of Rs. 375.6 billion in 2007/08 increased to Rs. 545.3 billion in 2012/13 and Rs. 627.8 billion in 2015/16 (MoF, 2017). In recent year, Nepal's outstanding debt has almost tripled from the last five year reaching Rs. 1.41 trillion in 2019/2020 and Rs. 1.51 trillion in the first half of the 2020/2021 fiscal year (Shrestha, 2021).

The discrepancy between the vastness of the available resources and the countless possibilities for food self-sufficiency, accelerated economic growth, and fast-paced socio-economic transformation of the society and the current level of agricultural imports, poverty, unemployment, social exclusions, and economic distress in Nepal raises many questions. One of the most important questions here would be, why is Nepal failing so grossly in tackling the issues of food self-sufficiency, employment generation, and economic development? The answer to this question is the lack of appropriate vision, strategies, commitment, and good governance. In order to best utilize natural and human resources for economic growth and environmental quality, there should be appropriate planning and development approach that identifies opportunities for economic growth, natural resources conservation and environmental quality, while addressing socio-economic inequalities in the society. Such a developmental model should be simple to understand, scientific, practical, all-inclusive, and socially fit. In subsequent sections, a

theoretically grounded Asta-Ja Framework (Poudel, 2008) for sustainable conservation, development, and utilization of natural resources and economic growth and socio-economic transformation of the country is presented. Then, discussions on Asta-Ja strategies and approaches to food, water, climate and environmental security, sustainable economic development, and social inclusion and the alleviation of inequities follow.

Asta-Ja Framework

Envisioning an equitable, socially just, environmentally sound, and sustainable society, a decade ago, Poudel (2008) published a groundbreaking framework of Asta-Ja meaning eight *Ja* in Nepali letter, *Jal* (water), *Jamin* (land), *Jungle* (forest), *Jadibuti* (medicinal and aromatic plants), *Janashakti* (manpower), *Janawar* (animal), *Jarajuri* (crop plants) and *Jalabayu* (climate) as a comprehensive resources planning and development approach for accelerated economic growth and fast-paced socio-economic transformation in Nepal. Asta-Ja elements are very intricately linked and strongly connected (Figure 1). Asta-Ja system constitute human and natural resources. It is important to have ecological balance among the eight elements of Asta-Ja for better functioning of the entire system. For sustainable development, it is important to view Nepal through the lenses of Asta-Ja and look for opportunities and possibilities that have competitive advantages on resources utilization, economic growth, and employment generation in the country. Asta-Ja is the backbone of Nepal's economy. Therefore, the best governance of Asta-Ja is the ultimate goal of a government.

Asta-Ja Framework reveals "*Jalabayu*" (climate) as the most critical and central element and driving force for all other elements (*Jal, Jamin, Jungle, Jadibuti, Janashakti, Janawar, and Jarajuri*) in Asta-Ja system. Any changes on weather or climatic conditions will influence all other *Jas*. It is necessary to give full consideration of all eight elements when utilizing Asta-Ja resources for economic development. Simply put, if a farmer in a smallholder mixed-farming system likes to be successful in livestock production, he/she should emphasize sustainable management and development of Asta-Ja resources so that a great deal of synergy would develop within Asta-Ja system resulting in a higher level of farm productivity and environmental quality. Asta-Ja Framework is a holistic, system-based, scientific, collaborative, interdisciplinary, participatory, self-reliance, and grassroots-based environmental and natural resources planning and management approach for conservation, development, and sustainable utilization of the eight resources within the Asta-Ja

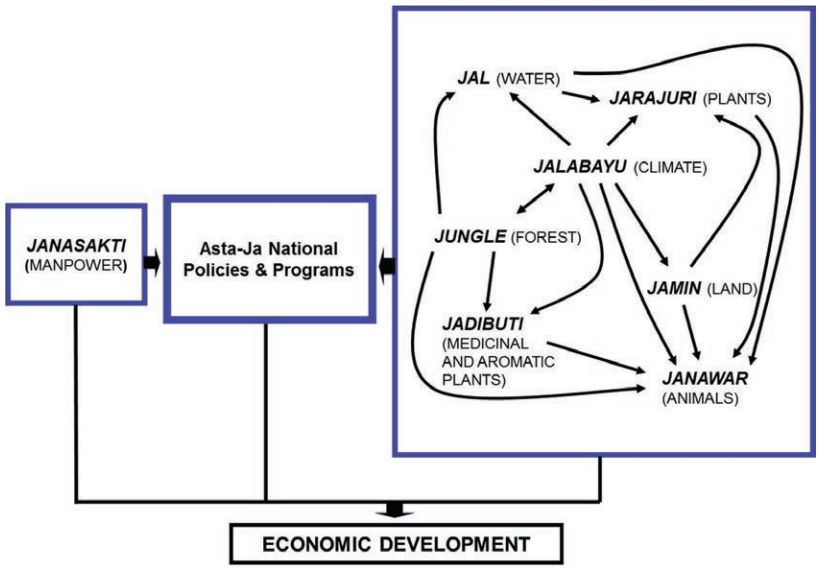

Figure 1 Interrelationships and linkages among Asta-Ja, and the formulation of national policies and programs for economic transformation (adopted from Poudel, D.D. 2008. Management of Eight "Ja" for Economic Development of Nepal, *Journal of Comparative International Management*, 11(1), 15–27; page no. 23, Figure 2).

system. Asta-Ja Framework relies on peace and negotiations rather than conflicts and disagreements when it comes to resources sharing, utilization, and development.

Just as Michael E. Porter (1998) proposed the four-diamond model (i.e. firm strategy, structure and rivalry; demand conditions; factor conditions; and related and supporting industries) for creating national competitive advantage in businesses for nations, Asta-Ja Framework is a holistic and peaceful business approach to sustainable utilization and marketing of the Asta-Ja products based on comparative advantages for accelerated economic growth and fast-paced socio-economic transformation. Asta-Ja Framework envisions sustainable development of environmental resources as conceived by the Brundtland Commission Report "Our Common Future" (WCED, 1987). Asta-Ja Framework aligns closely with the deep-rooted and famous concept of asta-Laxmi in Hinduism, which identifies the sources of wealth as money or gold, agricultural production, animals, progeny, valor and courage, victory, and knowledge, corresponding to the seven manifestations of the goddess of wealth as Dhana Laxmi (money Laxmi, giver of money and gold), Dhanya

Laxmi (grain Laxmi, giver of agricultural produce), Gaja Laxmi (elephant Laxmi, giver of animal wealth, like cattle and elephants), Santana Laxmi (progeny Laxmi, giver of offspring), Veera or Dhairya Laxmi (giver of valour in battles and courage for overcoming difficulties in life), Vijaya Laxmi (giver of a victory in battles or any hurdles to be successful in life), Vidhya Laxmi (knowledge Laxmi, giver of the knowledge), and Adi or Maha Laxmi (the first or primordial form of Laxmi, the origin of all existence, and the repository of all the wealth in the universe). The "asta" concept is ingrained in Hindu cultures and Nepalese society (Poudel, 2016a). Just as the *Pancha Mahabhut* (i.e. space, air, water, fire and earth) are described as five great elements that form the basis of all cosmic creation in Hinduism, the eight elements of Asta-Ja form the basis for sustainable economic development and socio-economic transformation.

The eight principles of Asta-Ja that serve as the guidelines for implementation of Asta-Ja Framework at grassroots level include, (1) Community awareness, (2) Community capacity-building, (3) Policy decision-making, (4) Interrelationships and linkages, (5) Comprehensive assessment, (6) Sustainable technologies and practices, (7) Institutions, trade and governance, and (8) Sustainable community development and socio-economic transformation. Detailed elaboration of these principles can be found in Poudel (2008, 2009, 2011 and 2012a). The principle of community awareness plays the central pivotal role in the Asta-Ja Framework. Grassroots communities are the ultimate change agents and the beneficiaries. Communities participating in the process of sustainable development and utilization of Asta-Ja resources, income generation, and socio-economic transformation must be sufficiently aware, engaged and educated on Asta-Ja system. The eight principles of Asta-Ja Framework match closely with United Nation's global Sustainable Development Goals (SDGs), declared at the UN's New York Convention on September 25–27, 2015 (UN, 2015).

> *The 17 SDGs are: Goal 1 End poverty in all its forms everywhere, Goal 2 End hunger, achieve food security and improved nutrition and promote sustainable Agriculture, Goal 3 Ensure healthy lives and promote well-being for all at all ages, Goal 4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, Goal 5 Achieve gender equality and empower all women and girls, Goal 6 Ensure availability and sustainable management of water and sanitation for all, Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all,*

> *Goal 8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, Goal 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, Goal 10 Reduce inequality within and among countries, Goal 11 Make cities and human settlements inclusive, safe, resilient and sustainable, Goal 12 Ensure sustainable consumption and production patterns, Goal 13 Take urgent action to combat climate change and its impact, Goal 14 Conserve and sustainably use the oceans, seas, and marine resources for sustainable development, Goal 15 Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss, Goal 16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels, and Goal 17 Strengthen the means of implementation and revitalize the global partnership for sustainable development* (UN 2015, page 5).
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> While SDGs Goal 1 through 8, 12, 13, 15, and 16 directly relate to Asta-Ja principle 8 (i.e. sustainable community development and socio-economic transformation) and principle 6 (i.e. sustainable technologies and practices), Goal 9 and 11 relate to principle 2 (i.e. community capacity-building) and Goal 10 and 17 relate to principle 7 (i.e. institutions, trade and governance). Asta-Ja Framework is well-recognized by many stakeholders including local communities, scholars, researchers, governmental agencies, international organizations and media (Duquesne, 2011, 2013; Poudel, 2016b; Bhattarai, 2017; Bhandari, 2019a). It is prudent for the Government of Nepal in adopting Asta-Ja Framework as its developmental platform and working closely with UN agencies on sustainable development of Nepal.

Asta-Ja Framework serves as a unifying framework for environmental and natural resources planning and management (Figure 2). Through this framework, all governmental and nongovernmental agencies, private businesses, community organizations, academia, international aid agencies and other stakeholders concerned with the Asta-Ja resources can come together in natural resources planning and management. Asta-Ja Framework promotes communication, collaboration, and coordination among its stakeholders.

Figure 2 Asta-Ja Framework as a sound unifying planning and management tool for environmental and natural resources planning, management and development (adopted from Poudel, D.D. 2016a. Management of Asta-Ja System, *Journal of Comparative International Management*, 19(2) 19–40, page no. 33, Figure 2).

Asta-Ja provides a common platform on which various stakeholders can sit together and discuss cross-cutting developmental issues, develop plans, and implement projects for sustainable development and environmental quality.

Asta-Ja promotes self-reliant development, which is proven as an appropriate strategy to be taken by countries especially following COVID-19 pandemic. Epidemics such as SARS, outbreaks of diseases such as Ebola, natural disasters, wars, and political disruptions affect supply chains. Asta-Ja promotes self-reliant development of Nepal through food and energy

self-sufficiency, organic agriculture, agro-jadibuti industrialization, promotion of small-scale cottage industries, renewable energy, development of sustainable technologies and practices, and sustainable community development based on locally available natural and human resources. COVID-19 pandemic has severely impacted Nepal (Ghimire and Khadka, 2020; Joshi and Khanal, 2020; Karna, 2020; Khadka and Poudel, 2020; Moktan and Poudel, 2020). Entrepreneurship development is critical for economic growth, employment generation and prosperity, and requires creating community awareness on the benefits of entrepreneurship, encouraging venture capitalists, and promoting partnerships and innovation, and marketing (Sharma, 2019). As a grassroots-based developmental model, Asta-Ja Framework enhances entrepreneurships, self-reliant development, and community resiliency through sustainable conservation, development and utilization of Asta-Ja resources, hence, the relevance of Asta-Ja Framework in economic development of post-COVID Nepal is exceptional.

Food, Water, Climate, and Environmental Security

Food Security

Increasing food insecurity is a major concern for Nepal. Several factors including, increasing population growth, failure of the past agricultural initiatives (Poudel, 2004), negligence from the Government of Nepal in agricultural development in past three decades, decade long Maoist insurgency, massive outmigration of youths for foreign employment, climate change impacts, land ownership and land fragmentation, and poor agricultural marketing and input supplies are responsible for food insecurity. More importantly, it is the faulty perspective on indigenous smallholder mixed-farming system taken by the policy-makers and planners on agricultural development. While western countries experienced the massive set back due to negative impacts of industrialized agriculture on family farms, rural employment, environment, public health, and financial sustainability and have started transforming the large-scale industrialized agriculture production into sustainable agriculture (organic and low-input systems), Nepal is still wrongly dreaming for large-scale modernized high-input agriculture, while it has a great opportunity for developing its own millennia evolved organic agricultural system to enhance food security, public health and environmental quality.

In the USA, the modern industrial agriculture got it first big boost in 1930s when the US government farm policies supported farmers for the use of chemical fertilizers and pesticides and built farm roads and communication system for large-scale industrialized farming with increased crop yields (Montague and Pellerano, 2014). This large-scale mechanized farming with the heavy use of chemical inputs helped in raising agricultural productivity putting developed countries in the position of supplying agricultural produce globally at low prices. However, the negative impacts of industrialized agriculture on environment, soil erosion, ecology, rural economy, small-scale farms and families, and human health started mounting. Environmental concerns of industrial agriculture continued to grow and it reached to a point of establishment of US EPA in 1970 following the publication of a classic book on environment, Silent Spring (Carson, 1962). While concerns on the impacts of industrial agriculture on public health and environment continued to rise, the global economic recession in early 1980s resulted in a big financial crisis to US farmers who had borrowed money for their large-scale industrial farming resulting in farm bankruptcies, foreclosures, and many farmers committing suicide (Ikerd, 2015). In order to reduce the production cost, support small-scale family farms, minimize environmental impacts, and respond to public health concerns, sustainable agriculture movement emphasizing organic agriculture started in 1980s. Accordingly, new governmental programs such as Sustainable Agriculture Research and Education (SARE) program, the long-term research projects such as Farming Systems Trial at Rodale Institute in 1981 and Sustainable Agriculture Farming Systems (SAFS) project at UC Davis, California in 1988, and USAID funded international cooperative research project such as Sustainable Agriculture and Natural Resource Education and Management Collaborative Research Support Program (SANREM CRSP), a consortium led by the University of Georgia in 1992, emerged. While the long-term farming systems projects started comparing the organic and low-input production systems to conventional, high-input agriculture, in relation to crop productivity, natural resource conservation, and environmental impacts, the SANREM CRSP started exploring sustainable ways of using land and other natural resources following a holistic and landscape/lifescape approach to agriculture through its three regional projects in Southeast Asia, the Andes, and West Africa, with focused research activities in the Philippines, Ecuador, and Mali, respectively. This author was very fortunate to join the incredible team of researchers at SANREM CRSP as a Ph.D. graduate student at the University of Georgia,

Athens, GA, USA, conducting dissertation research in Mindanao, the Philippines, 1994–1998, and SAFS project at UC Davis, California, as a Research Manager, 1998–2000. From his research works in these two programs, this author has published several research articles in relation to soil erosion and crop productivity, soil development, sustainability of commercial vegetable production systems, participatory farmer's managed research, fallow system (Poudel et al., 1998, 1999a, 1999b, 1999c, 2000), and comparison of organic, low-input and conventional high-input farming systems for nitrogen storage and loss, N-availability, crop yields, weeds (Poudel et al., 2001a, 2001b, 2002) and tomato fruit elemental composition and soil physical properties (Colla et al., 2000, 2002). These research publications suggest that conventional high-input farming systems are detrimental to environment and public health and the alternative production systems such as organic and low-input production systems have comparable yield while improving soil and environmental quality, reducing cost of production, and reducing the risk of public health. Sustainable technologies and practices emerging from participatory, interdisciplinary and holistic landscape/lifescape approach to agricultural development are necessary to enhance agricultural sustainability and environmental quality.

Nepal's food security issue revolves around increasing agricultural production, improved agribusiness, and integrated supply chain. There are five drivers of increased agricultural production and food security in Nepal. They are: (1) Smallholder mixed-farming system, (2) Incentives, (3) Pro-poor market, (4) Infrastructure, and (5) Policies and programs (Figure 3) (Poudel, 2019). These five drivers must be the focal points while designing agricultural development strategies and programs that aim for increasing agricultural production and food security in the country.

Smallholder mixed-farming system (driver 1), which is highly diverse, labor intensive, and strongly linked with the eight elements of Asta-Ja (i.e., livestock, forest, water resource, medicinal and aromatic plants, human resource, climate), is the "nucleus" of agricultural production and development in Nepal. The National Sample Census of Agriculture 2011/12 showed a total of 3,715,555 households engaged in crop production (having $>$ 0.01 ha land) and 115,538 households engaged in the production of livestock only (having $<$ 0.01 ha land) (NPC, 2013). About 90% of agricultural land is devoted to the production of cereal crops and remaining 10% under cash crops. The major reason of poor status of agricultural sector in Nepal is the gross neglect of smallholder mixed-farming system in the name of "subsistence farming" in terms of research and development, extension services,

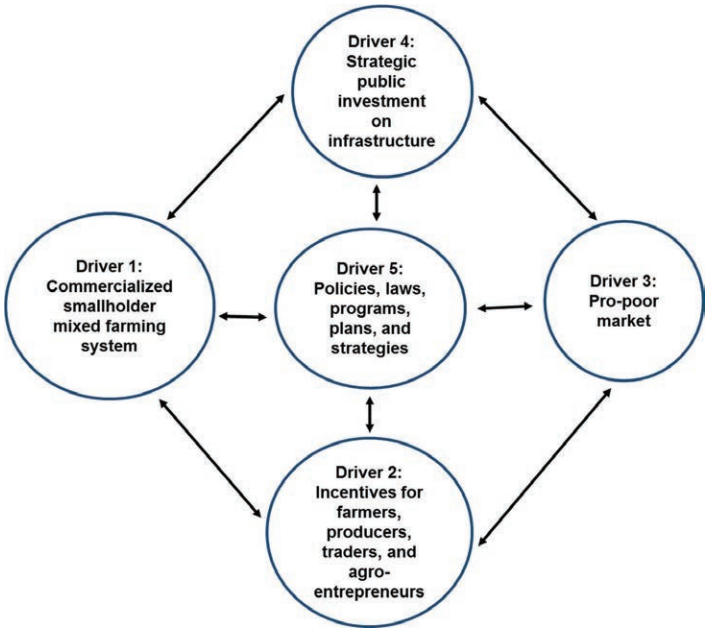

Figure 3 Five Drivers of Agricultural Developent in Nepal (Adopted from Poudel, D.D. 2019a. Agricultural and Natural Resources Development and Mangement Strategy in Nepal, *Asian Profile*, 47(1) 1–17, Page 9, Figure 1).

agricultural investment, and incentives. Being born and raised in a small family farm practicing mixed-farming system in the mid-hill region of Nepal, this author has a direct experience of the smallholder mixed-farming system. Land ownership and land holding size is the central factor in smallholder mixed-farming system. Along with social prestige and farm income guarantee, land ownership is strongly associated with food security and family nutrition (Poudel, 2021). However, 25% of Nepalese population is still landless or near landless (Leitner Center, 2011). In 2019, the Government of Nepal made eighth amendment to Land Act and has made provision of giving land rights to certain parcel of such lands to those landless people who are using government lands for last 10 years. It will address the issue of land tenure and provide a supportive environment for an increased agricultural productivity and food security. It is necessary to focus on research and development of smallholder mixed-farming system to increase its productivity, profitability, and employment generation while enhancing ecological balance among the elements of Asta-Ja (i.e. *Jal, Jamin, Jungle, Jadibuti, Janshakti, Jarajuri,*

Janwar, and *Jalabayu*). Design and management of appropriate cropping systems is necessary as the impacts of cropping system on soil erosion, drought and flood resistance, control of invasive plants and weeds, disease control, crop yields, and farm incomes are profound. Cropping systems that enhance soil physical, chemical and biological properties are associated with higher crop yields (Colla et al., 2000; Rämert et al., 2000).

Incentivized Individual Farmer, Trader, Supplier, and Agro-entrepreneur (driver 2) is another key driver for increased agricultural production. Appropriate incentives for individual farmers, agro-entrepreneurs, traders, suppliers, retailers, and other agents engaged in agricultural production, processing and storage, marketing and distribution is necessary for increased agricultural production and food security. Incentives for agribusiness, which involves input supplies; commercialized agricultural production; agro-industries, packaging and storage; and marketing of agricultural commodities, is critical for food security. Incentives in agriculture are necessary to compete with global food markets especially coming from industrial agriculture. Organic agriculture with appropriate governmental incentives will boost smallholder mixed-farming system. Cheaper international food prices hurt local production and rural economy. Highly diverse and at different scale agro-industries such cotton, jute, ginger, cardamom, forest products, rubber, cereal based industries, dairy, poultry, meat, fruits and vegetables, tea and coffee, and medicinal and aromatic plants are just a few example of commodities for possible agro-jadibuti industrial development in Nepal (Poudel, 2019c). Agribusiness create employment opportunities, which is necessary for Nepal, as the nation is experiencing a massive outmigration of youths for foreign employment. A highly coordinated approach is necessary for a successful agro-industrial development with an emphasis on entrepreneurship development, agricultural commercialization, research and innovation, financial assistance, supportive policy instruments, and national priority. It is important to pay attention to the large markets both in the north and in the south while setting up Nepalese agribusiness. Agri-business related to organic production, medicinal and aromatic plants, and industries based on forest products such as bamboo and hardwoods are very promising. Condiments and spices such as cardamom, ginger, turmeric, garlics, onion, prickly pears, and cinnamon are other potential products for small to medium size agro-industrial development. Similarly, given the unique climatic conditions and topography, Nepal has a great competitive advantage for off season vegetable production, vegetable seed production, and the production of exotic flowers and fruits. Highland vegetable production systems are quite productive

and are well-developed in Asian countries including Malaysia, Philippines, and Taiwan (Midmore et al, 1995, 1997, 1999). Nutrient application, labor saving technologies, and crop diversification were identified as key factors associated with sustainable vegetable production in the highlands (Poudel, 1998).

Development of pro-poor market for agriculture in Nepal (driver 3) is another critical driver. The government should play key role in developing pro-market by providing necessary physical infrastructure and institutions that support private sector and market dynamics. Increasing urban population is demanding more and more food supply every year. Due to the lack of appropriate supply chains, agricultural commodities produced in the farms are not reaching to the urban areas (Jansen et al., 1995; Poudel, 2018a). "Farmers are struggling for better prices for their produce and governmental support for marketing of their commodities. Small cooperatives formed in rural areas are not capable of undertaking bigger roles in processing, packaging, storage, and marketing of agricultural products primarily due to their limitations on capital and human resources, smaller volume of produce, lack of knowledge, and lack of necessary infrastructures. Therefore, regional and national marketing initiatives need to be undertaken by corporate or private businesses, corporations, or other joint venture entities who can invest in the necessary logistics, transportation, storage, and human resources. This brings an opportunity for vertical integration of cooperatives with corporate or private businesses, corporations, and similar other companies in the agricultural supply chain" (Poudel, 2018a). Currently, a total number of 34,512, with a total membership number of 6,305,581 operate in Nepal. These include: savings and credit (13,578), multipurpose (4,371), agriculture (10,921), milk (1,658), consumer (1,423), fruits and vegetables (193), tea (108), coffee (155), *Jadibuti* (184), bee keeping (93), communication (143), health (128), sugarcane (48), *Junar* (45), and other coops (999) (Poudel, 2018a). Agricultural cooperatives can take part in production agriculture at the local level. They can also take part on local level agri- marketing (input supplies, output collection, small-scale processing/packaging). Price guarantees and support, crop and livestock insurance, value-chain, branding, capacity-building, and farm machinery would be some of the key areas that cooperatives need help from the government. The formulation of appropriate policies, rules and regulations, and guidelines is necessary for this integration. A clear understanding and definition of the operational scope and boundaries of cooperatives and private businesses involved in production, marketing, and export of goods and services is of utmost importance for enhancing national competitiveness.

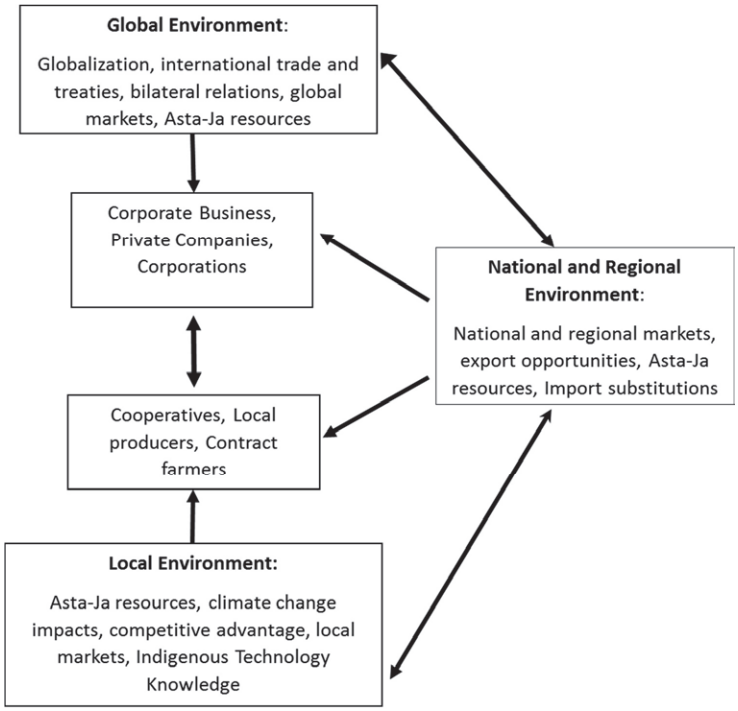

Figure 4 Generalized operational scope and the vertical integration of cooperatives with private businesses to raise national competitiveness in agricultural production, marketing, and exports. (Adopted from Poudel, D.D. 2018a. Management of Cooperatives Focusing on Asta-Ja and Globalization, *Journal of Comparative International Management*, 21(1):77–84, Figure 1, Page 82).

Figure 4 shows the generalized operational scope and vertical integration of coops with corporate and private businesses to raise national competitiveness in agricultural production, marketing, and exports. Corporate and private businesses must be more responsive to national/regional and global factors whereas cooperatives must be more responsive to local and national/regional factors. For food security, it is important to strengthen the value chains in rural areas where food availability is a problem.

The Government of Nepal should strategically invest on food warehouses, cold storage facilities, transportation, agricultural roads, communication, irrigation, power supply, education and outreach (driver 4). Lack of roads or poor road conditions, unreliable power supply or lack of power supply, and insufficient research on agricultural development were recognized by

the Agriculture Perspective Plan (1995–2015) as major bottlenecks for agro-industrial development in Nepal (NPC, 1995). Since agricultural produce include perishable products and have serious health impacts when they become contaminated and deteriorated, sufficient investment is necessary for cold storage preservation including safe handling and storage of the produce (Poudel et al., 2021). More than 30% of agricultural produce is lost in storage. Saving agricultural produce from storage loss is equivalent to producing a new crop. Establishment of food warehouses with cold storage facilities for food producers, community supported agriculture, or other production platforms at local level nationwide is critical to enhance food security.

Policies and programs, rules and regulation, and trade and agreements play crucial role in agricultural development by promoting agricultural production, processing, and exports (driver 5). Nepal's agricultural development process so far has largely a top-down, which needs to be changed into a bottom-up approach for accelerated agricultural growth. Current policies such as crop and livestock insurance, specialized crop production zones, agricultural modernization initiatives etc. should be well coordinated horizontally and vertically for their successful implementation. Land banks, land rehabilitation programs, lease companies, and other innovative approaches are necessary for expedited agricultural development. International trade agreements and treaties need periodic reviews, revisions, and update. Agriculture Development Strategy (ADS) 2015–2035 presents valuable framework for agricultural development. However, due to several implementation challenges including the federalization of governance and administrative structure, an immediate revision of ADS is necessary. Policies would be necessary with regard to natural resources conservation and development such as soil and water conservation, forest conservation and watershed management. Similarly, clear policies on organic pesticide development, technological development for packaging and storage, research and development on seed, irrigation management, cover crops, green manure, and livestock feed and nutrition and housing maybe necessary. Immediate actions should be taken to rehabilitate degraded lands across the nation.

Agricultural programs in Nepal need to implement soil health building practices including cover crops nationwide for food security. Cover crops are gaining attention as soil improving crops worldwide. Cover crops are planted when agricultural lands are fallow with the purpose of controlling soil erosion, increasing soil fertility, adding nitrogen and organic matter to the soil, improving overall soil health, suppressing weeds, decreasing nutrient

loss, attracting beneficial insects, suppressing diseases and enhancing biological activities of the soils rather than with the purpose of harvesting crops. Some of the commonly used crops as cover crops include oats, ryegrass, barley, sun hemp, hairy vetch, red clover, sweet clover, canola, pea, radish, turnips, alfalfa and theirs mixes. Cover crops can be planted in different seasons depending on crop rotation practiced. Because most agricultural lands are used for growing one or two crops in a year in Nepal, incorporation of cover crops between the two crops will help growing food crops more efficiently, increasing crop yields, and enhancing food security while taking care of climate and environment. Cover crop fields can serve as grazing land for livestock. Since most crop residue is taken out from the field for livestock feeding, agricultural lands in Nepal lack the addition of organic matter in the soils and have deteriorating soil productivity. More research is necessary for better understanding of cover crops planting and management, breeding, adoption, economics, and benefits. Because additional food has to be produced to meet rising demand from increasing population, there is no doubt that future course of agriculture lies on sustainable intensification and higher crop productivity while improving environmental quality and climate change adaptation. Therefore, the necessity of cover crops becomes critical in sustainable food production, soil management, and food security.

Water Security

Due to population increase, land use changes, economic development, and climate change, availability of drinking water in recent years has alarmingly declining especially in the mid-hill region of Nepal (Merz et al., 2003; Poudel and Duex, 2017). Poudel and Duex (2017) reported 12.2% of springs dried up in an agricultural watershed in the past ten years and remaining 73.2% of springs have decreased flow. Similarly, ICIMOD (2015) reported 15 to 30% of springs dried up in the past ten years in other watersheds in the region. Because of the springs dry up, local communities in rural areas are leaving their villages abandoning their ancestral properties behind. Declining the availability of drinking water is adversely affecting the socio-economic vitality of the region. Problem created by declining availability of drinking water is exacerbated by increasing water pollution (WaterAid Nepal, 2005; Warner et al., 2008). Drinking water pollution from various sources including sewage lines, septic tanks, open pit toilets, agricultural activities, industries, and waste disposal threatens public health safety (Poudel and Duex, 2017; Vaidya and Labh, 2017). A large number of local communities in the mid-hill

region of Nepal are also experiencing decline on irrigation water sources over the past ten years. They have even left planting wheat and other winter corps in some areas due to lack of irrigation water (Poudel, 2015). Irrigation canals are operating on half capacities in most areas. Drought has become a common phenomenon in recent years. In Terai region, depletion of groundwater table is forcing farmers to install their tube wells further down resulting on higher boring cost. Increasing demand for municipal water has also resulted in decline in irrigation water supplies. As the Terai region in Ganges basin consists of significant transboundary aquifers, it is important to have a high level of cooperation between India and Nepal for sustainable utilization of management of groundwater resources.

Water availability, water quantity and water quality constitute the three main components of water security. Water availability is associated with different water sources and access to water resources to meet various needs such as drinking water, agricultural and industrial water, religious and recreational water, hydropower, and fish and wildlife propagation. Water quantity relates to the availability of water in required amount to meet various needs. Water quality relates to the physical, chemical, and biological integrity of water bodies to meet various needs. Surface water pollution through point and nonpoint sources has become a worldwide problem. While point source of pollution can be controlled through issuing permits and licenses, controlling nonpoint sources of pollution is a very challenging task. This author has worked on nonpoint source pollution control of surface waterbodies in Louisiana, USA, and in drinking water sources in Nepal for past two decades and has published several research articles (Poudel and Jeong, 2009; Poudel et al., 2010; Poudel et al., 2013; Poudel, 2016b; Poudel and Duex, 2017; Poudel et al., 2020a; Poudel et al., 2020b). Results from the decades of his research work suggest that water quality issue is a very complex topic and it requires a highly coordinated water quality monitoring and the point and nonpoint source pollution control strategies.

Just the US EPA developed eight-step water-quality based approach to pollution control (US EPA, 1994), an eight-step water security framework for Nepal is presented in Figure 5. Major steps included in the framework are identification of water sources in each geographical or administrative unit and listing them up, designating their uses, establishing water quality standards for designated uses, assessing their status in terms of availability, quantity, and quality; developing appropriate policy measures for conservation, development and utilization of water resources; implementation of water resource development measures; evaluation of the status of water resources;

Figure 5 Water security framework for water availability, quantity, and quality in Nepal.

and reporting. Step 1, identification of water sources such as rivers, streams, springs, groundwater, lakes, and glaciers in a locality or region with unique ids and names is necessary for keeping track of the status of water bodies and water resources planning and development. Step 2 is the determination of the designated uses for these water sources. Designated uses may include drinking water, agricultural and industrial waters, recreational and religious waters, hydropower, and ecological and environmental waters.

Recreational and religious water bodies, fish and wildlife propagation waters, outstanding natural waters and hydropower reservoir waters need protection. Recreational waters include those water bodies that are used for recreational purpose such as white water rafting, boating and canoeing, swimming, and fishing. Recreational waters need to be protected against pathogens as contamination of these water bodies with pathogens such as E. Coli and other bacteria affect the health of publics. Several rivers, lakes, and other water bodies keep special religious significance to Nepalese people. Some of them include Baraha Chhetra in Sunsari, which is located at the confluence of the Koshi River and the Koka River. Similarly, Pashupati Temple in Kathmandu is located at the bank of the Bagmati River. Pancha Pokharai

in Sindhupalchowk district includes the five holy lakes which are located at the world's ninth highest altitude wetlands (4,100 m asl). Gosaikunda in Rasuwa, which is located at 4,380 m asl, is very famous holy place, which is a freshwater oligotrophic lake. The 108 faucets of Muktinath Temple in Mustang, which is located at 3,810 m asl is a famous religious water. Devghat, which is at the junction of the Seti River and Krishna Gandaki River in Tanahu and Chitwan districts, is a famous religious place for Hindus. It is important to identify these religious waterbodies in the nation and protect them for their religious significance. Fish and wildlife propagation is a very critical environmental and ecological service provided by water bodies. There are certain water bodies that are endemic to endangered species, for example, Karnali River for gharial crocodile. Contamination and pollution of water not only impact aquatic life but also other terrestrial wildlife. Water corridors for aquatic life including fish migration should be maintained. Many lakes and wetlands in Nepal are the attraction for winter migratory birds from the northern arctic countries and Siberia. The pristine environment of outstanding natural resource waters such as Phewa Lake located at 742 m asl in Pokhara, Kaski district, Rara Lake, the biggest and the deepest freshwater lake located at 2,990 m asl in Jumla and Mugu districts, Phoksundo Lake, located at 3,615 m asl in Dolpa district, and Tilicho Lake located in 4,919 m asl in Manag district, needs to be fully protected and maintained. Declining level of water during winter months and resulting low level of hydropower generation is a major problem. This decline in water level of reservoirs threaten the sustainability of energy supply. Appropriate water conservation measures are necessary to maintain water level during winter months. Step 3, development of water availability, quantity, and quality standards involves identification of physical, chemical, and biological parameters of water for water quality assessment, discharge measurement for volume of water availability, and uses of water for different purposes. Water quality standards generally include water color, temperature, turbidity, taste, suspended solids, odor, fecal coliforms, pH, biological oxygen demand, hardness, and various chemical constituents including N, P, K, Ca, Mg, Fe, and heavy metals. According to the Government of Nepal Ministry of Physical Planning and Works (2005), Nepal's National Drinking Water Quality Standards include the minimum and maximum limits, respectively, for the following: pH 6.5 and 8.5; Fe 0.3 and 3 mg/l; Fl 0.5 and 1.5 mg/l; and residual Cl 0.1 and 0.2 mg/l. Similarly, maximum concentration limits expressed as a recommended range include 5 to 10 NTU for turbidity and 5 to 15 TCU for color, respectively. Total dissolved solids and total hardness have maximum concentration limits

of 1000 mg/l and 500 mg/l, respectively. Maximum limit set for electrical conductivity is 1500 μS/cm. Maximum concentration limits for As, Cl, SO_4, NO_3, and Ca are 0.05 mg/l, 250 mg/l, 250 mg/l, 50 mg/l, and 200 mg/l respectively. Maximum limit for total fecal coliform is 0 MPN/100 ml for 95% sample and 0 MPN/100 ml for E-coli. Water quality standards are to be revised every 3–5 years. Step 4, assessment of water resources should be a regular process, and it is done on a periodic basis. Water quality monitoring and modelling helps in identifying hotspots for pollutants in the watershed or a region (Poudel et al., 2013; Poudel, 2016b). Centralized water quality database should be updated regularly as the new data arrives. Water assessment is done for designated section of water bodies, lakes or reservoirs on a weekly basis, every two-week basis, or seasonal basis. Identification of key water parameters is needed for assessment. Water assessment team should be well-trained and water analysis labs should be established and developed for assessment. Step 5, policies and strategies are necessary for conservation, development and utilization of water sources. Wide range of water policies are necessary in tackling point and nonpoint source of pollution, drinking water source protection, rejuvenation of springs, hydromodification, construction of reservoirs and dams, soil water management, farming practices, groundwater, rainwater harvesting, etc. Policies should be developed through active participation and the involvement of all stakeholders in the policy process. Step 6, implementation of water sources development measures and practices is necessary for water sources conservation, development and utilization. Various measures may include afforestation, groundwater recharge, lifting drinking water, drinking water supplies, irrigation canals, groundwater utilization, pollution control and other measures. It will also include water conservation in agricultural lands, wastewater recycling and watershed water conservation. Point source pollution control should be done through appropriate permit system. Managing water demand for industrial, agricultural, municipal supplies and ecological uses is necessary for sustainable use of water resources. Step 7, water quality monitoring in terms of availability, quantity and quality is the central part for water security. Without proper knowledge on water sources and their availability and quantity and quality, no water security can be realized. Monitoring should include edge of field, streams, rivers, groundwater and household water supplies. Step 8, regular reporting the status of water sources in terms of water availability, quantity and quality is necessary. Regular reporting on the implementation of water resources conservation, development and utilization in the region will help in formulating new policies and programs for sustainable management of water

resources enhancing water security. National water resources conservation, development and utilization measures should be integrated in each district's water security plans.

Institutional development for water resource management constitutes a necessary step towards water security. A lead authority for water security should be designated and a strong collaborative platform for water quality assessment, monitoring and evaluation, point and nonpoint source pollution control measures and implementation of strategies for drinking water source protection as well as sustainable conservation, development and utilization of water resources is necessary. Community education, awareness and participation in water conservation and development becomes integral component of water security. A holistic approach that includes forest conservation, irrigation management, drinking water supplies, and water pollution control is essential to enhance water security. Water bodies should be prioritized for water quality monitoring and the implementation of pollution control measures. A rotational basin/watershed approach may be taken to minimize monitoring cost. Establishment of appropriate institutional mechanism for water security at the national, regional and district level is necessary.

Climate Security

Declining precipitation, increasing temperature, extreme rain events, droughts, and emerging diseases and parasites are some of the major evidences of climate change in Nepal (Bhandari, 2012; Yang et al., 2014; Poudel, 2015; Poudel and Duex, 2017). Consequently, climate change impacts in terms of increasing risks of flash floods, decline in yield of agricultural crops, food security, biodiversity, soil erosion and land degradation, drying springs, and forest degradation are observed (Sharma, 2010; Devkota and Bhattarai, 2012; World Bank, 2015; Bhandari, 2018, 2019b). Climate change impacts on livestock health and nutrition and livestock production is another serious problem (Poudel et al., 2014). Due to low level of economic development and high dependency on agriculture for economic growth, vulnerability of Nepalese society to climate change impacts remains very high. Bajracharya et al. (2011) identifies Glacial Lake Outburst Floods (GLOFs) and variability on river flow as the two major impacts of climate change affecting hydropower, agriculture and rural livelihoods in Nepal. Due to climate change impacts, human risks such as food and water insecurity, migration, loss of infrastructure, economic loss, social violence, political unrest, human traffic, and increase poverty level and distress have increased in recent decades

(Poudel and Duex, 2017; Sugden et al., 2014; Bhandari, 2018). Because of drying springs resulting in lack of drinking water, many local communities in the mid-hill region of Nepal have migrated out leaving their ancestral properties behind. Nepal is experiencing frequent flooding in recent years. While the Western Nepal flood that occurred in the month of August in 2014 destroyed many infrastructures and houses and displaced more than 20,000 people, the Terai Flood in 2017, which also occurred in the month of August, destroyed 41,000 houses completely, damaged 151,000 houses partially, and displaced 460,000 people temporarily, resulting in a total loss of more than Rs. 63 billion (Poudel, 2019d). Similarly, the 2019 July flood that affected thirty-two districts across the country killed at least 117 individuals, injured 80 people, displaced approximately 80,000 people and damaged much infrastructure, food stocks, and crops. It is urgent to take climate security issue and start working on building climate resilient society. Figure 6 presents climate security framework for reducing climate risks to human society and building community resiliency in Nepal.

Figure 6 Climate security framework for reducing climate risks to human society and building community resiliency in Nepal.

The Climate Security Framework (Figure 6) starts with understanding the climate change as the first step in climate security. Global warming is causing climate change worldwide. The atmosphere contains all the air and earth systems with 78% N_2, 21% O_2 and 1% other gases (IPCC, 2007 as in Bhandari, 2020).

> *"The atmosphere extends from below 1 m earth surface to more than 10,000 km above the earth surface. About 96% of the 1% other gases is Argon (a noble gas) and only 0.04% of the 1% other gases include atmospherically active trace and heat trapping gases called the greenhouse gases. These greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), fluorinated gases (hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, nitrogen trifluoride, etc.), nitrogen monoxide, carbon monoxide, sulfur dioxide, and carbon disulfide. These greenhouse gases are emitted from various activities including burning of fossil fuels (coal, petrol and diesel, natural gas), biomass burning, landfill sites, livestock and agricultural production, and industrial activities. The long-lived greenhouse gases such as N_2O and CH_4 are transported to the stratosphere (20 Km – 50 Km above the sea level) where they play roles in O_3 destruction resulting in the thinning of O_3 layer. The stratospheric O_3 layer is necessary for blocking much of the ultraviolet radiation entering into the earth surface and regulating Earth's radiating balance. On the other hand, in troposphere (earth surface to 20 Km above sea level) short-lived greenhouse gases such as CO, NO_2, NO react with CH_4 and other hydrocarbons to form ozone, which is a pollutant causing respiratory illness and crop damages. At lower atmosphere, the reradiated sun's energy from the Earth surface is adsorbed atmospheric gases mainly by CO_2, N_2O, and CH_4 and cause warming of the earth surface, which is known as "Greenhouse Effect". Of all the greenhouse gases, CO_2 is most critical one in relation to its increasing concentration and volume as well as its atmospheric heating effect. The warming effect in the lower atmosphere by greenhouse gases are driving global climate change, resulting global warming (i.e. rise on the Earth's surface temperature). The consistent rise on the global temperature after the Industrial Revolution (1750 – 1850 AD) has become a major threat to the Earth system including human." (Poudel, 2019d)*

Currently, average global temperature is above 1.1 degree Celsius above the pre-industrial average global temperature. The volume of atmospheric CO_2 has increased by more than 40% compared to pre-industrial era (1750 AD) and has higher than any point in the past 800,000 years. Based on the measurement at Mauna Loa, Hawaii, USA, atmospheric CO_2 concentration of about 315 PPM in 1950's has now reached to 420.44 PPM as of May 1, 2021. As the CO_2 concentration has been increased steadily, the global temperature, which was below 0^oC until 1940 and fluctuated positively and negatively during 1940–1980, has been rising consistently above 0°C reaching almost 1°C in 2010 (Bennet, 2016). Therefore, it is urgent now to control the emissions of CO_2 and other GHGs in order to check further rise the global temperature. Global temperature rise is influencing precipitation, wind direction, ocean currents, and many other weather variables resulting in the changes of existing climates across the globe (IPCC, 2014; IPCC, 2018).

The step 2 Climate Security Framework involves the assessment of risks to human society from declining drinking water sources, drought, flood, emerging diseases and parasites, agricultural loss, forests degradation, wildlife losses, ecological degradation, people and wildlife migration, and social and political conflicts. Climate change impacts are exhibited in the form of melting ice caps, sea level rise, extreme rain events, flooding, hurricanes, wildfires, droughts, and emerging new diseases and pests. Climate change impacts on lands, waters, forests, food production, plant and animal species, cultural heritage sites, tourism, people's livelihoods, public health, natural ecosystems, and many others ecosystem processes. In order to assess climate risks to human society, various existing information and data sources together with new datasets generated through multiple sources including Participatory Rural Appraisal, Rapid Rural Appraisal, Key Informant Surveys, household surveys (Poudel, 2015; Poudel and Duex, 2017), satellite images, and other sources can be used.

Climate Security Education and Community Awareness, Step 3, involves education and bringing community awareness to climate security through various processes including formal education, training, outreach activities, media, and other means of communication. Educational events such as Envirothon, Environmental Challenge Programs, or School Children Field Days are effective measures in teaching agricultural, climate change and environmental issues and raising awareness among schoolchildren and local communities (Poudel et al., 2005). For climate security, it is important to understand the linkages between human society and Asta-Ja system. Community should be sufficiently aware that climate change impacts flood, food

production, wildfire, drought, outmigration, social disharmony, public health, and even national security issue. Public health issue may emerge due to outbreak of diseases and malnutrition because of lack of food supply. Social and political unrest due to climate change disturbs peace and harmony in the society.

The Step 4, Risks Mitigation and Adaptation to Climate Change, includes various activities such as Climate Smart Agriculture, introduction of green infrastructure in the cities, rainwater harvesting, development of drought resistance varieties, water conservation, reducing water pollution, protection of forests, flood protection, water conservation, and resiliency building. Reducing emissions of greenhouse gases, use of renewable energy, carbon sequestration, and Reducing Emissions from Deforestation and Forest Degradation (REDD+) are some of the viable measures to fight climate change. Nepal has been trying to implement Reducing Emissions from Deforestation and Forest Degradation (REDD+) program with a view of conservation, sustainable forest management, and enhancement of forest carbon stocks. Major challenges identified for REDD+ implementation include confusion on tenure, weak governance, and high opportunity cost (Paudel et al., 2013). Robust flood prediction computer models will help design and implementation of flood protection and mitigation measures (Wang et al., 2019). In recent years, agriculture developers talk about Climate-smart Agriculture (CSA) as an approach for developing agricultural strategies to secure sustainable food security under climate change by increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing greenhouse gas emissions. Agriculture-smart practices includes conservation agriculture, IPM technologies, greenhouse tunnels, drip irrigation, agroforestry practices, drought resistant varieties, and improved livestock sheds, feeds and fodders. It will also promote the use of drought resistant varieties in agricultural production. In order to reduce agriculture's contribution to climate change, composting, carbon sequestration, green manuring, and improved cooking stoves are suggested. Water conservation is done through several water-smart practices such as roof-top rainwater harvesting, mulching, runoff water collection, and the construction of water storage tanks. Bio-diversity smart practices include establishing home gardens and community forestry nurseries. In built-in environment, various mitigation and climate change adaptation measures include wide spectrum of activities including developing hydrologic model for flood control (Wang et al., 2019), water supply, power shortages, sea level rise, tropical storms, drainage system, green infrastructure, and groundwater

management. Published in 2018, the IPCC special report "Global Warming of 1.5°C" presents the impacts of global warming of 1.5°C above pre-industrial level, and discusses related greenhouse gas emission pathways. Mitigation measures to keep global warming as close as possible to 1.5°C include: the reduction in energy demand, decarbonization of electricity and other fuels, electrification of energy end use, deep reductions in agricultural emissions, carbon dioxide removal (CDR) with carbon storage on land or sequestration in geological reservoirs, and low energy demand and low demand for GHG-intensive consumption goods (IPCC, 2018).

The Step 5, Policy Changes, Climate Change Governance, and International Agreements, involves various measures and strategies in relation to climate security policy decisions promoting hazard mitigation and climate change adaption and implementation of interdisciplinary sustainability-oriented programs. Such policies and governance should encompass cross-cutting social, economic, environmental, and resource management dimensions of sustainability. Government of Nepal has developed the National Adaptation Program of Action (MoFE, 2018), which has identified climate adaptation needs across 6 cross-cutting sectors: agriculture and food security, water resources and energy, climate-induced disasters, forests and biodiversity, public health, and urban settlements and infrastructure. Along with the periodic review and revisions, immediate implementation of the NAPA program at the national, regional and local level is necessary. The Paris Agreement sets the goal of limiting global temperature rise less than 2°C compared to pre-industrial global temperatures and aims at climate change adaptation by developing countries with sufficient support from developed countries. Continued engagement of policymakers representing governmental agencies, academia, private businesses, nongovernmental organization, and international agencies on climate security dialogue and policy decision-making is necessary for climate security (UNFCCC, 2007; UNEP, 2019; Bhandari, 2020).

The Step 6, Monitoring Climate Security, involves regular monitoring of key measures of climate security such as flood disaster, GLOF, wildfires, drought, and migration of people due climate change impacts, and drinking water shortages and other impacts in human society. Such a monitoring system keeps track of data on agricultural productivity, forest conditions, climate variables such as precipitation, temperature, humidity, wind speed, extreme rain events, and incidences of diseases and pests. Information on the impacts of climate change on both agriculture and natural resources and built-up environments will be necessary. Climate Security monitoring scheme

should include national, regional and local levels of monitoring. Climate Security monitoring may also include monitoring of GHGs emissions form cities. Collaboration with various agencies and stakeholder organizations and local communities will be necessary for information collection.

The final step, Step 7 Reporting Climate Security, involves regular publication of reports on climate security and community resiliency. Various reports may include climate change prediction and projections, hazard mitigation and adaptation measures, climate security indicators, policy changes and international agreements, case studies, scientific research findings, etc. These reports will show the status of climate change impacts on human society. Making such publications available from a single portal will enhance their accesses by the readers and stakeholders. Such reporting will help on raising public awareness of climate change impacts and climate security, enhancing natural hazard preparedness, and eventually influencing appropriate policy decision-making for climate solutions.

Environmental Security

Environmental degradation has become a major public health concern in Nepal (Das et al., 2018; Poudel et al., 2020b). Most cities in Nepal, including Kathmandu Valley, are engulfed in air pollution, water pollution, and soil contamination (Rupakheti et al., 2017; Kandel and Aryal, 2020). The presence of thick haze in the atmosphere across the nation is very disturbing. Major causes of environmental pollution include rapid and haphazard urbanization, increasing number of vehicles and energy consumption, emissions from industries, heating, burning woods and other trash materials, transboundary air pollution, chemical uses in agriculture, poor and failing septic systems, exposed ground surfaces, and poor disposal of solid and hazardous wastes. In addition to threatening public health, damaging wildlife habitat, and deteriorating recreational uses of natural resources, environmental pollution is adversely affecting the aesthetics, tourism, ecological integrity, and economic activities (Hali et al., 2019a, 2019b, 2019c). Unsafe disposal of hazardous and biomaterials including e-waste is spreading highly toxic substances which are often long lasting in the environment. Negative consequences of pollution from urban areas is now spilling over to sub-urban and village areas. Environmental security depends on sustainability of ecosystem services such as clean air, clean water, nutrient cycling, food production, disease control, climate regulation, and aesthetics. Developmental projects such as roadways, hydropower, freshwater diversion, transmission lines,

airports, railways, ropeways, reservoirs, sanitary landfill sites, and industrial and chemical plants have significant environmental impacts including social, economic, ecological, biological, human health and wildlife. Often the impacts of such projects are ecologically devastating such as extinction of plant and animal species, serious public health impacts, and the occurrence of anthropogenic natural disasters such as subsidence, sinkholes, landslides, earthquakes, tunnel collapses, and land degradation. Because it is often too costly to retrofit environmental projects when the problems occur, it is prudent to have a thorough investigation of proposed developmental projects in relation to its environmental impacts before making decision on its implementation. Human activities such as deforestation, sand and gravel mining, river pollution, improper disposal of municipal solid waste, pesticide usages, and dumping of industrial wastes in waterbodies or land are just a few examples that potentially put all plants, animals, and microorganisms at risks. Risks to organisms may include physical injuries, degradation of their habitats, toxicity, affecting their food sources, diseases and parasites, inclusion of invasive species, and extinction. Leaking Underground Storage Tanks (USTs) such as petroleum and other hazardous materials storage facilities, may cause significant public and ecological health concerns. Petroleum leaks from USTs are found to have caused serious soil, surface water, groundwater, and indoor air pollution. Contaminants from leaking petroleum tanks such as methyl tertiary butyl ether (MTBE), benzene, toluene, ethylbenzene, xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), total combustible hydrocarbon (TCH), volatile organic chemicals (VOCs), and petroleum hydrocarbons (PHCs) are found to have caused cancer, heart diseases, and decreased immune system. They are also found affecting the central nervous system, lungs, and kidneys (Poudel, 2021a). Degradation of natural resources such as forests, water resources, agricultural lands, rangelands, and wildlife cause deterioration of environmental security. Massive degradation of Churia region due to deforestation, land use changes, landslides, debris flow, river cutting and gravel and rock mining is a major environmental security challenge of Nepal (Poudel 2012b; Bannister, 2016). As a professor of environmental science at University of Louisiana at Lafayette, Lafayette, Louisiana, USA, for the past 21 years and teaching several undergraduate and graduate courses in Environmental Science program and conducting environmental research, this author has realized that the environmental security hinges on its three main components: environmental pollution control, environmental assessment and remediation, and natural resources conservation. Figure 7 presents the environmental security framework with its three main components.

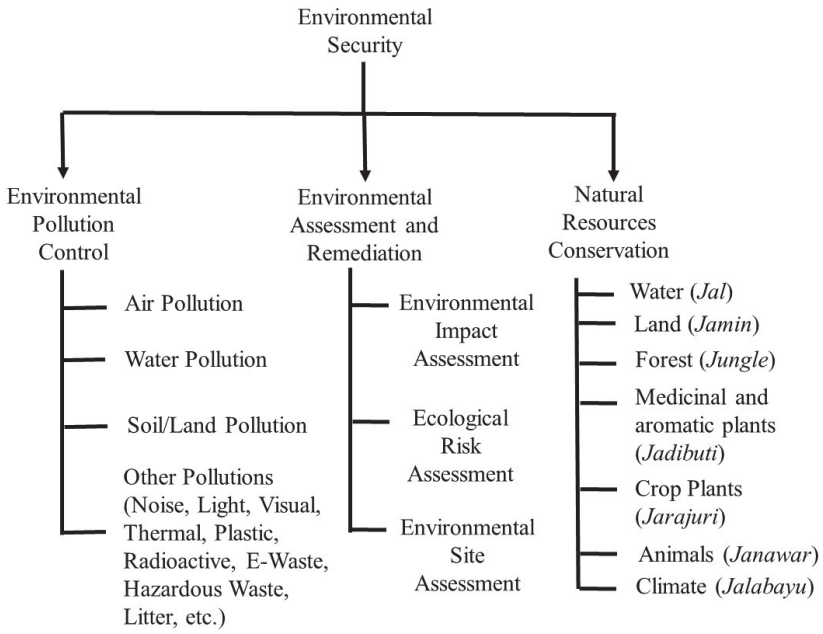

Figure 7 Environmental security framework with three components, environmental pollution control, environmental assessment and remediation, and natural resource conservation.

Environmental Pollution Control

Kathmandu Valley's AQI reached 541 (hazardous category) in April, 2021. Most months in a year have very poor air quality (Das et al., 2018; Corwin et al., 2019a, 2019b, 2019c). The ambient Air Quality Standards generally include PM_{10}, $PM_{2.5}$, SO_2, CO, O_3, NO_2, and Pb. Cities in the Terai region are also experiencing similar air pollution in recent years. Domestic air pollution sources include biomass burning, brick industries, vehicular emissions, thermal plants, wildfires, and other sources of air pollution. Airborne dusts and aerosols from chemical sprays and fertilizer applications are additional sources of particulate matters in the air. The presence of thick haze over Nepal for most part of a year is causing poor visibility and has serious environmental consequences (Poudel, 2019d). With its radiation effect in the upper atmosphere, the haze is causing temperature rise of the upper layer resulting in glacier melting. In the meantime, it has a "dimming" effect on the earth surface with many impacts including a decrease on surface temperature, reduced evaporation and precipitation, decreased monsoon, reduced vegetation growth and increased winter chills. This haze is known

as "Asian Brown Cloud". This environmental problem was first detected by the United Nations Environment Program (UNEP) in 2002 following an extensive research known as the Indian Ocean Experiment (INDOEX) (Mitra and Sharma, 2002). This very intensive atmospheric research conducted in 1999 over the Indian Ocean revealed that there is a three-kilometer-thick man-made pollution, largely from October-November to March-April in the atmosphere over South Asia, East Asia (China), and South East Asia. The "Asian Brown Cloud" later described as the "Atmospheric Brown Cloud" is mainly due to the presence of anthropogenic aerosols such as soot (mainly black carbon) and dusts produced through industrial and vehicular emissions, thermal plants, and burning biomass. Sulfates and nitrates are other aerosols found in the brown cloud (Poudel, 2019d).

Since the origin of the transboundary air pollutants lies outside the political boundary of a nation, cooperation among the nation states is necessary for controlling transboundary air pollution. Measures such as switch to clean energy, economic incentives for pollution control, and use of environmentally sound production and manufacturing technologies will help controlling transboundary air pollution. Drinking water pollution due to pathogen, suspended solids, nutrients and due to arsenic in Terai region is a serious concern (Werner et al., 2008; Rai et al., 2009; Shrestha, 2012; Poudel et al., 2020). Warner et al. (2008) reported total coliform and Escherichia coli bacteria in 94% and 72%, respectively, of all drinking water samples collected in Kathmandu Valley. Groundwater pollution continue to increase as urbanization, industrialization, and improper disposal of municipal and industrial solid waste, hazardous substances, and leaking underground storage tanks (USTs) continue to rise. For environmental pollution control, it is necessary to follow the steps of pollution assessment, identification of the causes of pollution, development and the evaluation of standards, determination of the protection levels, definition and allocation of control responsibilities, implementation of pollution source control measures, monitoring, and measuring progress. A clear plan of action in addressing air, water, and soil pollution as well pollution from specific sources such as solid wastes, hazardous waste, sewage treatment plants, Underground Storage Tanks, and storm water is necessary.

Environmental Impact Assessment

Environmental Impact Assessment (EIA) is an important approach to sustainable development and management of natural resources. Environmental Impact Assessment is an umbrella term used in the evaluation of proposed

developmental projects or policies with regard to their implications on all aspects of environment including biophysical, socio-economic, and cost. The approach of EIA emerged from the US National Environmental Policy Act 1970 (NEPA). Environmental Impact Assessment also involves identification of alternatives and their evaluation for the best possible actions. EIA is recognized globally as one of the necessary approaches to sustainable development and management of natural resource and environment. Under the umbrella of EIA, a number of assessment approaches are developed including Health Impact Assessment (HIA), Social Impact Assessment (SIA), and Strategic Environmental Impact Assessment (SEIA). HIA is emerging as a serious component in recent years as community and individual impact of developmental projects and policies have become increasingly major concern globally. Another emerging approach is the Sustainability Assessment (SA), which focuses on the environmental sustainability due to proposed plans, policies, or projects. Many other assessment approaches such as Regulatory Impact Assessment (RIA), Cultural Impact Assessment (CIA), Post-disaster Impact Assessment, Human Rights Impact Assessment, and Climate Change Impact Assessment can be found in the literature and practice. Climate Change Impact Assessment is a very complex issue, and it requires reconciliation of national policies and programs to greenhouse gas emissions, global warming, and climate change adaptation strategies. Broadly speaking, the process of EIA can be divided into three major components: (1) Scoping, (2) Impact Prediction and Evaluation, and (3) Environmental Impact Statement. The "Scoping", which is a key step in EIA, involves: (a) defining criteria for assessment, (b) identifying data gaps for assessment, (c) identifying potential environmental, socio-cultural, bio-physical, and other impacts on the communities including livelihoods and access of local communities to the resources, and (d) setting range of alternatives in meeting the objectives. Sufficient time and resources is necessary for comprehensive baseline data (quantitative and qualitative) collection, compilation, analysis and synthesis. The second key step in EIA is the "Impact Prediction and Evaluation" of the proposed and the alternative activities. In this step, the issues identified in "Scoping" are analyzed, the types of impacts are identified, and their magnitudes are predicted. Modelling may be necessary in order to understand, for example, hydrodynamics, fate and transport of contaminants, ecosystem processes, etc., at this step. The third step in EIA is the "Environmental Impact Statement", which is the development of an Environmental Impact Assessment document. This document should present potential alternatives with in-depth analysis in relation to their environmental, socio-cultural, economic, public health,

hydrology, and many other impacts and selection of the best alternative for implementation. The document should present the environmental and other impacts of the proposed project in a clear and understandable format for public evaluation. Sufficient time should be given to the public for reading, discussing, digesting, and supporting or rejecting the EIS.

While EIA is mandatory by law in Nepal, its effective implementation is a matter of concern. For first time in Nepal, the need for EIA for large developmental projects was mentioned in the Sixth Five-Year Plan (1980–1985) and the Seventh Five-Year Plan (1985–1990) incorporated nationwide environmental management policy. National EIA Guidelines were developed in 1992. Then, two major environmental policies, Environment Protection Act 1997 and Environmental Protection Regulation 1997, were enforced in 1997. These acts require the proponent to prepare Initial Environmental Examination (IEE) and EIA and get approval from governmental authority for the implementation of a developmental project. It is important that people understand, internalize, and take active part in the EIA processes and on the implementation of mitigation measures for minimizing environmental, socio-economic, cultural, biological, ecological, hydrological, and other impacts. Governmental agencies and other concerned institutions must educate public and promote its active participation on EIA process for better environmental quality and sustainable natural resources. Development of EIA techniques and approaches that allow quick and better Environmental Impact Assessment is necessary.

Ecological Risk Assessment

Ecological Risk Assessment (ERA) involves the identification of actual and potential risks to plants, animals and the ecosystem due to release of physical, chemical or biological contaminants in the environment or any changes in the environment. Based on ERA results, appropriate regulatory mechanisms are developed for risk management or mitigation. The ERA employs two distinctive methods: (1) assessment of the risks because of existing conditions or activities that have already happened (descriptive), and (2) assessment of risks for possible authorization of new substances such as pesticides or other hazardous materials for use (predictive). Risk assessment for new substance requires strong predictive techniques in order to predict the risks in real-world situations from results generated in controlled laboratory and field experiments. The descriptive method tries to assess the risks considering the changes in the ecosystem that have already occurred. While there exist

several, often quite detailed and complex, frameworks for ERA, in broad term it involves three phases: (1) Conceptualizing the risks or hazards, (2) Evaluating the exposures, stressors and linkages, and (3) Characterizing the risks. The "Risks Conceptualization" phase includes: (a) collection of comprehensive baseline data (quantitative and qualitative) in relation to various stressors and their potential adverse effect on plants, animals, forests, and ecosystem, (b) identification of source-pathway-target linkages, and (3) site characterization. The second phase of ERA, the "Evaluation of the Risk" involves the formal risk assessment following the establishment of source-pathway-target linkages. At this stage, quantitative information or laboratory data is generated in relation to the concentration, distribution and mobility of stressors; nature, pathway and duration of the exposures between the sources and the targets; characteristics of the targets, and the nature of the effect. Many scientific questions such as how do the stressors enter into the organisms, what is the dose and response mechanism, how do the receptors behave, etc., are answered. The "Risk Characterization" phase involves the synthesis and reporting of the information generated in previous two stages. At this stage, actual and potential risks associated with plants, animals, forests, and ecosystem are presented. Various risks may include loss of biodiversity, incidences of diseases and parasites on plants and animals, loss in ecosystem services, disruption in food chain, forest degradation, extinction of a species, loss of agricultural land, sedimentation of lakes, and many others. Depending on the severity of these risks, the policy makers can design appropriate policies and strategies to control or minimize ecological risks associated with human activities. Control measures could be related to the management of the stressors such as modification or reduction and breaking the source-pathway-target linkages.

Because of human activities and climate change impacts, many animals and plant species in Nepal are listed as endangered species and this list continue to grow. Some of the animal species included in the endangered lists include red panda, snow leopard, Bengal tiger, one-horned rhino, Himalayan musk deer, Ganges River Dolphin, swamp deer, pangolin, striped hyena, and Asiatic elephant. Similarly, some of the endangered plant species in Nepal include *Champ, Jatamasi, Sarpaghandha, Panch aaule, Yarsagumbha*, and Lauth Salla. At least 45 medicinal and aromatic plants are listed as endangered species in Nepal. Out of 500 species of medicinal plants used in traditional medicines that grow in forests only 50 of them are in commercial use. Together with governmental initiatives, strong community participation is critical for the conservation and protection of endangered species.

Ecological Risk Assessment serves as the basis for developing landscape level cooperative management, monitoring, and research activities in relation to targeted plant and animal species that are at ecological risks.

Environmental Site Assessment

Environmental contaminations of industrial and commercial facilities, underground storage tanks (USTs), waste disposal sites, or any real estate that holds toxic substances become public and ecological health concerns. The owners of such properties should be responsible for their cleanups, which often require a lot of resources and time. In order to avoid the future financial risks of cleanups, the purchasers of such properties need to understand the environmental conditions of the properties before the purchase decision is made. Regulatory agencies also need to understand the human health and environmental risks associated with such sites, which depends on many factors including the condition and type of the receptors, site conditions, fate and transport of contaminants, concentration of the contaminants, and exposure of the receptors (Poudel, 2021a). Environmental Site Assessment (ESA) is done with a view of understanding the presence of contaminants in the sites, establishing exposure and toxicity risks, and taking remedial actions if the exposure and toxicity risks shown is unacceptable against established criteria. Consisting of site characterization, exposure assessment, toxicity assessment, risk characterization, and remediation, ESA involves a three-phase approach.

In Phase I ESA, initial investigations and preliminary risks assessment is done through site characterization, identifying historic activities at the site which may be the sources of contaminants, and describing the nature and extent of contamination. Wide range of environmental information such as local topography and geology, drainage, surface cover, vegetation, status of ground water, approximate depth to water table, proximity to surface water, and proximity to drinking water supplies, annual rainfall, flood potential, land and water use for the nearby areas is collected, and existence of any regulations and policy measures are assessed (Poudel, 2021a). Preliminary risk assessment involves establishing causes and effects of pollution, background exposures, route of exposures, does-effect relationship, eco-toxicological risks, bioavailability of the contaminants, and the combined effects. Based on Phase I report, the ESA Phase II is conducted in which detailed field investigations, quantification of the risks, and the preparation of ESA report is done for the contaminated site. In Phase II ESA, various field investigation techniques such as surficial sampling and analysis of vegetation, surface

water, and soils; subsurface sampling of soil vapors, soil and groundwater; geophysical investigations for buried objects; and longer term monitoring of surface water, soils, gas, and groundwater may require. Then, the risks are quantified based on the field and laboratory results. Based on the ESA Phase II report, the Phase III ESA is done in which remediation technologies or practices that are stipulated in Phase II report for the remediation of a contaminated site are evaluated. Appropriate remediation plan and design, which may include the use of various engineering and ecological remediation techniques, is developed involving local stakeholders and concerned governmental agencies.

> *"There are several ex-situ and in-situ techniques employed in remediating contaminated sites. Ex-situ remediation includes techniques such as excavating the contaminated soils and bringing it to a facility for driving off volatile organics and destroying other contaminants, vacuum extraction and temperature treatment. Ex-situ treatments are costly but effective. In-situ techniques are usually preferred in which treated soils are in place and are less costly and less destructive. Some of the common in-situ treatments that are used for the removal of contaminants from the soils include water flushing, leaching, vacuum extraction and heating. Pyrolysis technology includes heating soil at temperature of 1,400–2,000°C and decomposing or volatilizing organic matters. The stem produced through heating is treated. Plants such as prairie grass, sunflower, and spring wildflowers are used for treating contaminated soils, and the technique is called phytoremediation. Plants remediate contaminated soils through hyperaccumulation or through enhanced rhizosphere phytoremediation. Hyperaccumulating plants take up the contaminants from soils and accumulate them in their tissues, which are harvested and removed. Soil contaminated with Ni, Zn and certain organics such as TNT (trinitrotoluene) can be remediated using hyperaccumulating plants. In some cases, plant roots exude certain carbon compounds, which enhance microbial activities in the rhizosphere and decompose the contaminants. Applying voltage at the two sides of soil forming electric gradient and attracting heavy metals, a technique called electrokinetic remediation, electromigration, electroosmotic flow, or electrophoresis is a new evolving technique in the remediation of contaminated soils. Another technique of remediating*

> *contaminated soils include the use of N and P fertilizer and maintaining appropriate C/N ratio so that naturally occurring microorganisms can degrade the contaminants (biostimulation). Treatment of contaminated groundwater is much difficult. Certain surfactants such as Quaternary Ammonium Compounds (QACs) are applied to form organoclays to attract nonpolar organic molecules in groundwater and hold them until they degrade. Certain bacteria can also be inoculated in the polluted zone of groundwater (bioaugmentation) to breakdown contaminants and remove as harmless gas."* (Poudel, 2021a).

Natural Resources Conservation

Forest degradation due to several reasons including poor growing environment, drought, deforestation, illegal logging, and forest invasion by invasive plants is a serious problem in Nepal. Overharvesting of forests to meet firewood needs of local communities in rural areas is a persistent problem. Key drivers of deforestation and forest degradation in Chitwan-Annapurna Landscape, for example, include unsustainable harvest of forest products, infrastructural development, forest encroachment, agricultural expansion, forest fires, overgrazing, invasive plants, landslides and floods, stone mining, and recreation (WWF Nepal, 2013). Forest degradation affects wildlife habitat, biodiversity, biomass production, and hydrology. Although Community Forestry program is taken as a great success in Nepal, it still has several problems including implementation challenges, inconsistent policies, rules and regulations; lack of pro-poor programs, exclusion of ultra-poor people in management decision making, elite capture of the resources, and inequitable sharing of the benefits (Gurung et al., 2011). Similarly, Nepal is struggling with several national parks management challenges, which include connectivity and corridors, landuse changes, deforestation, poaching, and park-people conflicts (Thapa, 2016). Overharvesting of medicinal and aromatic plants, garbage disposal, and lack of designated trekking areas constitute additional park management challenges in Nepal. Widespread degradation of agricultural lands due to soil erosion, compaction, depletion of plant nutrients, acidification, soil pollution, destruction of soil structure, loss of soil carbon, and decline on soil biodiversity is another major concern. Conversion of agricultural lands to other uses is an additional major problem in Nepal. In 2015, total agricultural land area dropped to 4,228,548 hectare, which was less than 142,262 hectare as compared to 2001. Land degradation is also

occurring due to landslides, debris flow and deposition, sedimentation, river cutting, overgrazing, and deforestation.

While medicinal and aromatic plants are recognized as an important source of income and their trade is increasing, concerns on unsustainable harvest, degradation of medicinal and aromatic plants resource base, and the presence of unfair markets are rising (Larsen and Smith, 2004; Larsen and Olsen, 2007). Emphasizing the national economic importance of trade of medicinal and aromatic plants, Olsen (2005b) estimates the total annual harvest of medicinal and aromatic plants in Nepal ranging from 7,000 to 27,000 tons, 14,500 tons harvested in 1997–1998, with the market value US$7-30 million. In order to better conserve and utilize medicinal and aromatic plants, various strategies including pasture ownership and rights, sustainable harvesting practices, preservation of indigenous knowledge and skills, formation of regional forum for medicinal and aromatic plants, and community management are suggested (Larson and Smith, 2004; Olsen, 2005b; Devkota, 2006).

The Government of Nepal, in collaboration with many international developmental aid agencies, has taken multitudes of natural resources conservation, development and utilization initiatives for decades aiming sustainable management of natural resources such as forests, land, irrigation water, crop varieties, animal breeds, wildlife, medicinal and aromatic plants, mineral and mines, and natural beauty of Nepal (Shrestha, 2007; Poudel, 2008). Some of the major initiatives taken on natural resources management can be cited as the Chure Conservation program, National Biodiversity Strategy, Hariyo Ban Program, Wildlife Management Project, Adaptation for Smallholder in Hilly Areas project, REDD+ Implementation Programs, Agroforestry and Community Forestry, Climate Resilience of Watersheds, Watershed Management, Soil and Water Conservation, Kailash Sacred Landscape Conservation Initiative (KSLCI), Building Resilience to Climate Related Hazards (BRCH), and Community Based Flood and Glacial Lake Outburst Risk Reduction Project (CFGORRP) (MoFE, 2018; MoEN, 2019). Following the enactment of National Parks and Wildlife Conservation Act 1973, Nepal embarked on establishing national parks, wildlife reserves, and conservation areas for natural resources conservation and development and tourism promotion in the country, currently hosting 20 protected areas (national parks, wildlife reserve, conservation areas, and hunting reserve) (Shrestha, 2007; MoFE, 2018). However, massive degradation of resources in agricultural and natural systems is still a major concern. Natural resources degradation in agricultural and forest systems resulting in lower productivity is a persistent problem

(Poudel, 1991; Midmore and Poudel, 1996; MoAD, 2014). Drying springs is an increasing and widespread environmental and hydrological problem where natural springs are the major source of drinking water for local communities, water for household uses, irrigation water, livestock water supply, and water for wildlife (Poudel and Duex, 2017). Understanding linkages between agricultural and natural resources, local communities, and governmental policies and programs is necessary for sustainable development of agriculture and natural resources (Poudel, 2016a).

"The Environmental Policy and Action Plan of 1993 and the Environmental Protection Act of 1997 include a broad scope of environmental and natural resources such water, land, forest, air, rangeland, health, education, urban and industrial development, natural and cultural heritage, and public resource management" (Chapagain, 2001). However, implementation failures of these policy measures have become a major concern. Policy failure and resource degradation occur largely due to the formulation of policies without having comprehensive knowledge of natural resources and socio-economic conditions (Gautam, 2006). The Asta-Ja Environmental and Natural Resources Policy Framework (Asta-Ja ENRPF) (Figure 8) fulfills the gap in the arena of environmental policy formulation and implementation. To enhance sustainability of agricultural and natural resource systems, a broad range of factors such as political, socio-economic (National Research Council, 1993), biophysical, institutional, informational (Poudel et al., 1999), and international should be recognized and take into account while making policy decisions.

Sustainable Economic Development

Economic development requires a clear vision, strategies, investment, good governance, and political stability. Vision and strategies must be developed by considering the challenges a country is facing and the assets available at its disposal. Considering current challenges that the Nepal is facing and Asta-Ja resources as key assets of the nation, Poudel (2018b) published Nepal Vision 2040 aiming for elevating Nepal at the par of a developed nation within next two decades (Figure 8). Nepal Vision 2040 identifies nine strategies for sustainable economic development of the nation. These strategies include food self-sufficiency, renewable energy, tourism, exports, corruption control, infrastructural development, community resiliency, social services, and sustainable conservation and development of Asta-Ja resources.

As discussed in earlier section on food security, Nepal has great potential for being food self-sufficient through the development of smallholder

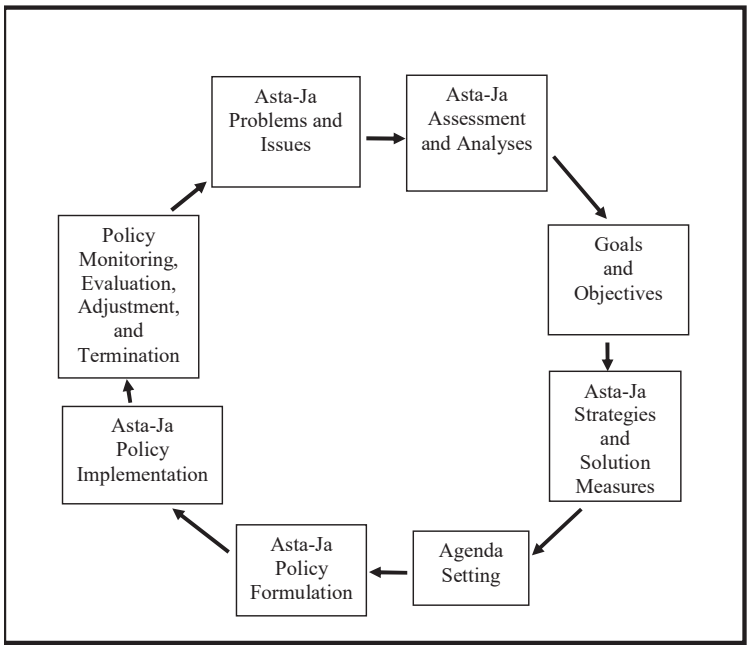

Figure 8 The Asta-Ja Policy Cycle (Adopted from Poudel, D.D. 2009. The *Asta-Ja* Environmental and Natural Resources Policy Framework (Asta-Ja ENRPF) for Sustainable Development in Nepal. *Journal of Comparative International Management,* 12(2): 49–71. Figure 1, Page 62).

mixed-farming system. Nepal can also export energy to neighboring countries after meeting her needs. According to Chapagain (2017), Nepal's total demand for electricity will reach 6,000 MW – 11,000 MW by 2025 and 20,000 MW – 51,000 MW by 2040. Alternative energy sources such as solar, wind, and biofuel can augment energy production. Nepal should accelerate generation of hydropower and start utilizing electricity and alternative energy in households and other uses reducing pressure on forest for fuel woods. The vast Himalayan range with beautiful Mountain and Terai landscapes serve as the major tourist destinations for the world. Along with conventional tourism, Nepal must focus on eco-tourism and religious tourism. Nepal also has opportunities for production and export of high-value products including organic produce, medicinal and aromatic plant products, bottled drinking water, electricity, and other high-value commodities. Presence of unique agro-ecological zones, naturally isolated production belts, smallholder mixed-farming production system, and the existence of traditional knowledge

for agricultural production favor organic production. Organic foods are more nutritious and healthy (Poudel and Wildman, 2001).

> *"Agricultural industries such as rice, corn, wheat, millet, sugar, floriculture, fruits and vegetable, dairy, poultry, livestock, fish, spices and condiments; food manufacturing; and, different agricultural inputs and business along with diverse Jadibuti industries which include various medicinal, cosmetic, household products, nutrition and dietetics, and organic pesticides are necessary for accelerated economic growth and demand immediate attention for their development"* (Poudel, 2019b, 2019c).

Corruption control must be the highest priority of the government. It has infested almost all sectors of the country including public, political, private, judiciary, civil service, police, army, and NGOs (Poudel, 2011). Major reasons for uncontrolled corruption in Nepal include failure in the implementation of anti-corruption measures, inadequate laws and regulations, and the lack of institutional capacity for enforcement. Infrastructural development such as construction of roads, airports, irrigation canals, ropeways, hydropower stations, and the establishment of agro-industries incur heavy expenditures. However, such projects directly influence local communities through employment opportunities, transportation, market access, and production of goods and services. Establishment of Nepal Army Corps of Engineers for construction, supervision, and the maintenance of large construction projects will expedite infrastructural development in Nepal.

Community resiliency entails building communities that are less vulnerable to the impacts of natural disasters such as earthquakes, floods, hurricanes, tornadoes, landslides or climate change (Poudel, 2016c; Bhandari, 2018). Increased investment on infrastructures such as urban development, flood control, communication system, early warning system, evacuation routes, etc., and income diversification, and community capacity-building is necessary for developing resilient communities against natural disasters and climate change impacts (Poudel, 2016c; Poudel 2019d). Lack of good planning and poor infrastructural development in the urban areas of Nepal has resulted in several urban problems including traffic congestions, environmental pollution, lack of open spaces, poor aesthetic and climate change vulnerability of urban population (Adhikari, 2019). Nepal has many complex issues and challenges on social service sector mainly education, health, drinking water, support for vulnerable groups, and pollution control. Streamlining Nepalese education system so that it comes within the reach of every citizen

is necessary. In the meantime, advancement on higher level of education and research is critical. Conservation and sustainable development of Asta-Ja resources is necessary for sustainable economic development. In order to expedite the process of sustainable economic development by conserving and utilizing Asta-Ja resources, it is important to have a very conducive planning and development apparatus in the country. Currently, the planning and development system of Nepal is seriously underperforming. National plans developed by NPC are poorly coordinated between programs and the budgets, highly politicized, and are failure in their implementations. National plans are lacking clarity on their long-term visions (NPC, 2021). In order to develop a robust planning and development process to accelerate economic growth and realize fast-paced socio-economic transformation of the nation, it is critical to restructure NPC focusing on Asta-Ja resources. A new structure of the NPC has been presented in Figure 9, which contains an Asta-Ja Assembly of Experts and Policy Makers and forms six units: Project Analysis and Development; Project Implementation, Monitoring & Evaluation; Policy Research and Advisory, Capacity-building; Data Analysis and Synthesis; and Planning. Of particular importance in this new structure includes the formation of the Asta-Ja Assembly of Experts and Policy Makers from the members

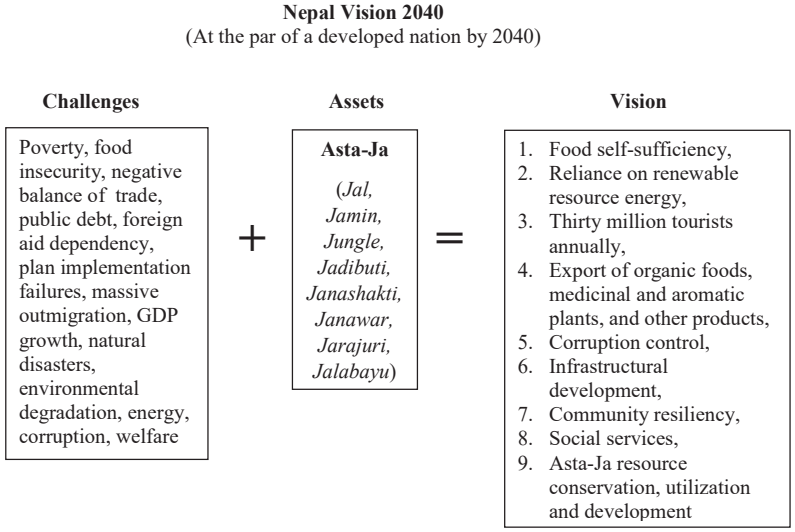

Figure 9 A Simple Diagram Showing the Development of Nepal Vision 2040 (adopted form Poudel, D.D. 2018b. Restructuring National Planning Commission Focusing on Asta-Ja and Nepal Vision 2040, *Asian Profile*, 46(2):151–167, Figure 1, Page 156).

identified and recommended by a nonpartisan Parliamentary Committee and ex-officio members from PMO, line ministries, academia, industry, national security, provincial governments, and other stakeholders. This provision will replace the current mechanism of NPC members coming directly from the political parties in the government. The NPC members recommended by the Parliamentary Committee will have a five-year appointment coinciding with the election cycle.

Together with domestic funds, Nepal needs to attract substantial amount of foreign investments for infrastructures and industrial development. Foreign Direct Investment (FDI) has become one of the major investment schemes driving financial economics of developing countries. Various forms of foreign aids include bilateral and multilateral aids, grants and loans. Since Nepal is situated in a strategic location and has unique geopolitical environment, it is important for the Government of Nepal to have clear policies in relation to FDI. Nepal needs to create favorable environment to attract FDI as FDI flow is substantially low in Nepal compared to its neighboring countries (Nepal Rastra Bank, 2018). Government of Nepal's decision on hedging the exchange rate to promote FDI is commendable. Nepal has been trying to attract FDI by following one window policy and creating Investment Board past three decades. However, success rate in attracting FDI is dismal. Major reasons for this failure include lack of transparency, lack of political commitment, corruption, poor selection of the projects, and negligence in identifying the impacts of these projects on national economy (Jha, 2020). Even with several tries including investment summits and passing laws, the FDI inflow accounted for only 0.79% of GDP in 2017. FDI in Nepal has increased from $67 million in 2018 to $185 million in 2019, which is a very poor growth. Based on Nepal's 2019 GDP of 30.64 billion US dollar and FDI inflow at a rate of 3% of GDP, Nepal should easily attract about $1 billion US dollar in FDI. It clearly shows that there is a huge gap in the potential for FDI inflows and current level of FDI in Nepal. The potential sectors for FDI in Nepal include hydropower, transport, agriculture, tourism, information communication technology, mines and minerals, health and education, manufacturing and financial institutions (Nepal Rastra Bank, 2018). In the current digital world, it is critical to have business opportunities digitally available so that interested parties can get the information as needed domestically or internationally.

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

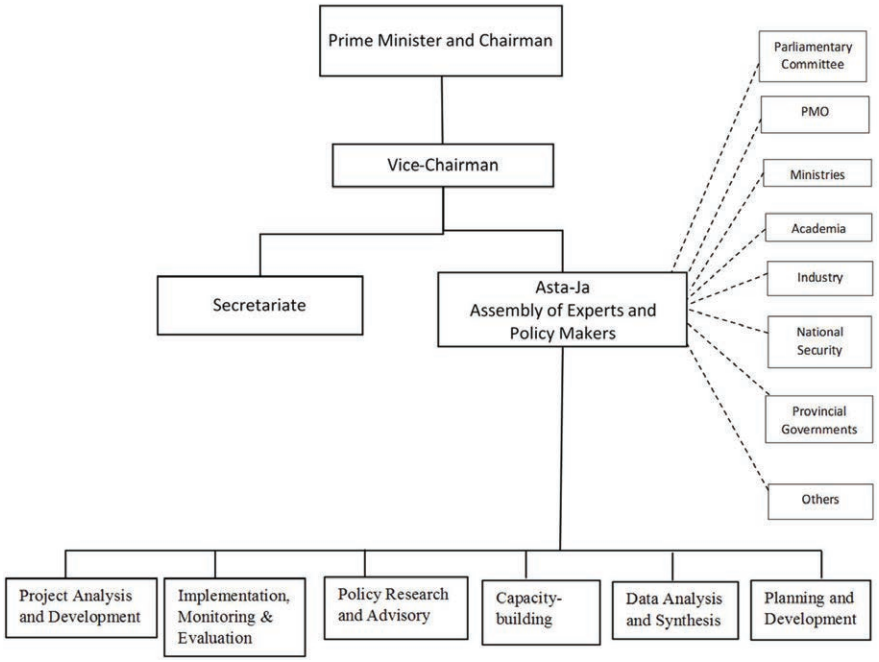

Figure 10 Proposed Organizational Structure of the National Planning Commission of Nepal (adopted from Poudel, D.D. 2018b. Restructuring National Planning Commission Focusing on Asta-Ja and Nepal Vision 2040, *Asian Profile*, 46(2):151–167, Figure 2, Page 162).

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. All of this information should be updated and made easily available to the users. Figure 10 shows a scheme for Asta-Ja Investment Information System (AJIIS) in Nepal (Poudel, 2011).

Following the devastating 7.8 Magnitude Gorkha earthquake on April 25, 2015, and a second 7.3 Magnitude earthquake on May 12, 2015, Nepal is still facing a historic challenge of re-building its historic sites, building structures, cottage industries, and economy. Almost 9,000 people were killed and more than 19,000 were injured by the earthquake. There was a complete loss of more than half a million building structures and the destruction of over 500 temples in Kathmandu Valley and 15 districts across the nation.

Since agriculture is the main occupation of rural communities and is the repository of many medicinal and aromatic plants, it is quite logical to give major emphasis on agro-jadibuti industrialization for rural re-construction and development (Poudel, 2016c).

Good governance is necessary for the society for development. Governance is the process of decision-making and how the decisions are implemented or not implemented. Asta-Ja Framework principle # 7 Institutions, Governance, and Trade emphasizes the importance of governance and institutional development for development of Asta-Ja resources. In good governance, local communities and people can participate in decision-making and in delegating authority to right people and trusting them for decision-making and implementation for the benefit of local communities. Good governance ensures service delivery, accountability, and transparency. Good governance is critical for removing corruption from the society. Once good people and trustworthy and ethical people are elected from the society and are involved in decision making and implementation of projects then corruptions is controlled by itself, projects are implemented very well and society moves forward. Poor governance is responsible for financial mismanagement. Powerful local government is very necessary for the implementation of projects that are of great concern to the local communities. Local communities must pay attention to the election and the power of their local government rather than the power of the national government. Mishandling of governmental resources, incapable of project development and successful implementation, and lack of coordination of programs and projects in the region and at the national level manifest poor governance.

Political Stability is critical for sustainable economic development. Political process dictates how the people and representatives are selected and how the state and federal institutions are governed and socio-economic development processes are implemented or strategies are made. Lawmakers are responsible for appropriate policy formulation. Government stability is very essential for just rule of law, transparency, responsiveness of institutions, and project implementation. Accountable government and elected officials are crucial for economic development. Lack of violence, government effectiveness, control of pollution and regulatory quality establishes the legitimacy of the governance. Political legitimacy is the belief that once the government is justified how to use the power and rights. Government's authority is accepted and the government is legit. People once in the power follow rules and regulations and maintain the legitimacy. Legitimacy strengthens political stability. Political legitimacy is critical for sustainable economic development. Along

with poor developmental infrastructure, chronic incapability of government on spending available developmental budget in a timely and transparent manner has become another problem in Nepal. Under these circumstances, there is a clear need to find way out of these complexities and expedite Nepal's developmental process focusing on economic growth, employment, and national resiliency.

Social Inclusion

Nepal is a highly diverse, multi-ethnic, multi-racial and well integrated society. Nepalese society is perhaps the best example of the highest level of peace and harmony among the most diverse ethnicities and linguistic groups in a country. In the meantime, like any other societies in the world, Nepalese society also has serious social discriminations such as caste differences, untouchability, economic and gender inequalities and other social discriminations. Bhandari and Hana (2021) reveal various factors of inequality embedded within the social, economic and political systems and argue that inequality can be seen as a global communicable disease of human civilization. Social inequalities are widespread in all human societies, which push minorities in disadvantageous position. The caste system, which was legalized by the Muliki Ain (Civil Code) of 1854, was abolished in 1963. However, caste-based discrimination is still widespread. There are stern social restrictions on marriages, worships, gatherings, and festivities between and within caste system. Caste system segregates people in the society, and talents, skills, integrity, and qualities of individuals from lower caste and hierarchy are often undermined, ignored, or not respected. Almost 25% of Nepalese population is landless or near landless (Leitner Center, 2011). Inequity also exists on health services, employment and business opportunities, and access to the state's resources. Various factors including resource inequities, social discriminations, and livelihood insecurity have resulted in political unrest, social conflicts, and community displacements in Nepal (Upreti, 2010). Despite several governmental and non-governmental efforts and initiatives in addressing ingrained issues of caste, untouchability, social discrimination, and other inequalities, alleviating social inequalities and eradicating untouchability and social discrimination is still far-fetched. International efforts on addressing these issues by requiring governments granting human rights and imposing bans on any form of discriminations are commendable. It is necessary to address all these multi-racial and multi-ethnic inequalities, while focusing on sustainable economic development and

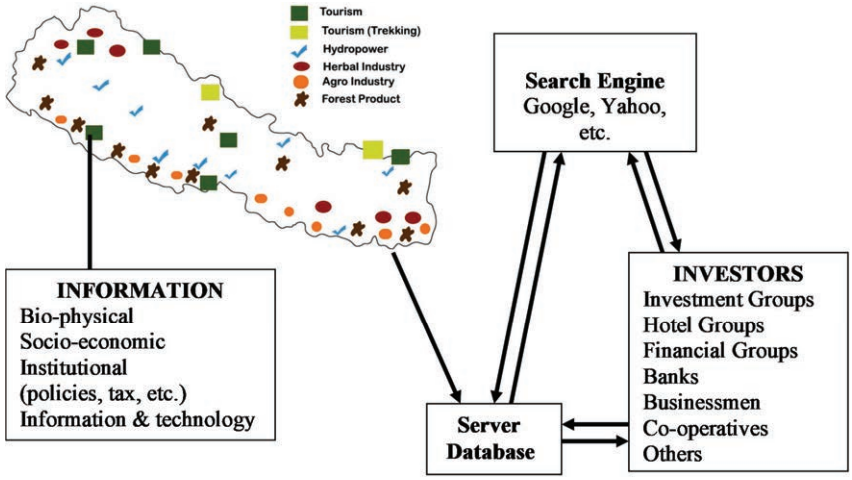

Figure 11 Asta-Ja Investment Information System (AJIIS) (adopted from Poudel, 2011. A strategic framework for environmental and sustainable development in Nepal. *International Journal of Environment and Sustainable Development*, 10(1):48–61, Figure 1, Page 57). *The symbols on the map do not represent any ground truth of geographic locations or political boundaries*.

socio-economic transformation. It is important to address the issue of social inclusion and equity at the local level.

Asta-Ja Framework takes community capacity-building (Asta-Ja principle no. 2) as its major strategy in addressing social exclusions and inequities through self-reliant development at local level (Figure 11). It promotes community awareness and engagement in resource planning and management and utilization as the starting point for equity, social inclusion and economic development. In this approach, community members sit together and discuss resource management and utilization. They democratically solve their problems. Asta-Ja Framework pursues nonviolence approach on resource sharing and economic development. By using Asta-Ja Log Frame (Poudel, 2016a), local communities identify alternative measures having competitive advantages for socio-economic uplift of the grassroots communities. Table 1 shows a hypothetical Asta-Ja Log Frame for Kathmandu Metropolitan City. Asta-Ja Log Frame consists of a matrix of Asta-Ja resources (*Jal*, *Jamin*, *Jungle*, *Jadibuti*, *Janashakti*, *Janawar*, *Jarajuri*, and *Jalabayu*), and the eight principles of Asta-Ja (community awareness, capacity-building, public decision making, interrelationships and linkages, comprehensive assessment, sustainable technologies and practices, institutions, trade and governance,

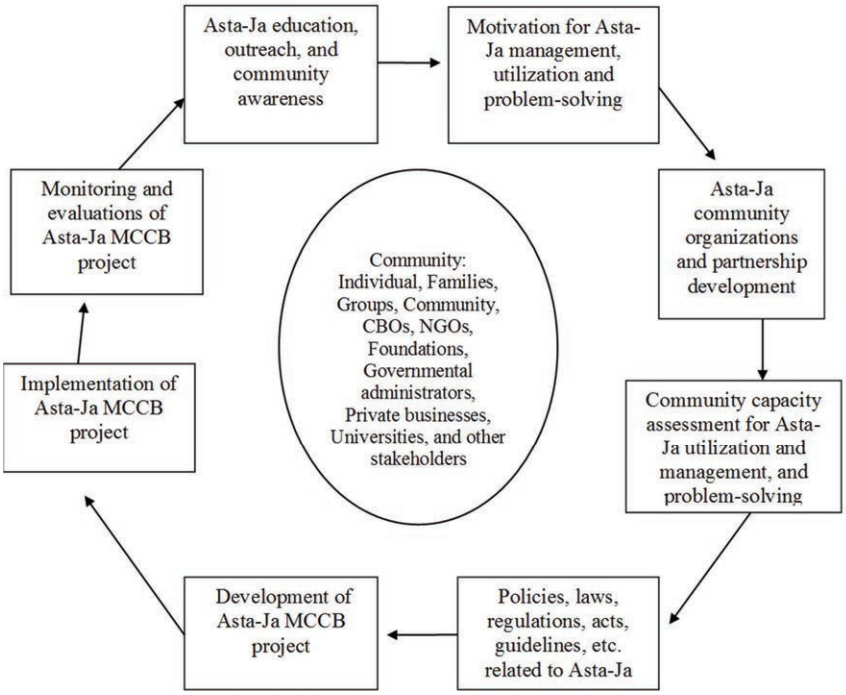

Figure 12 Asta-Ja management community capacity-building (Asta-Ja MCCB) process (adopted from Poudel, 2012a. The Asta-Ja Management Capacity-building Framework for Sustainable Development in Nepal, *International Journal of Sustainable Development,* Vol. 15, No. 4, pp. 334–352. Figure 2, Page 341).

and sustainable community development and socio-economic transformation). Asta-Ja Log Frame captures emerging issues and concerns related to natural resource in the locality, serves as an instrument for resource planning and management, and educates local communities and stakeholders in natural resources planning and management. It serves as the major document for resource planning and development and capacity-building. Additional information could also be collected using other instruments such as questionnaire, key informant surveys, focus group discussions, or participatory rural appraisals (Poudel, 2015). Information generated through log frames must be archived and undergo periodic analysis and synthesis. Social inclusion projects may range from organic agriculture, medicinal and aromatic plants, agro-industrial development, drinking water project, irrigation, tourism, handicrafts, outdoor recreation, and others that create employment, generate incomes, and gear communities towards sustainable development.

Table 1 A hypothetical example of Asta-Ja Log Frame for the City of Kathmandu, Nepal (adopted from Poudel, D.D. 2018b. Restructuring National Planning Commission Focusing on Asta-Ja and Nepal Vision 2040, *Asian Profile*, 46(2):151–167, Table 1, Page 164)

	Community Awareness	Capacity-building	Policy Decision Making	Interrelation-ships and Linkages	Comprehensive Assessment	Sustainable Technologies and Practices	Institutions, Governance, and Trade	Sustainable Community Development and Socio-economic Transformation
***Jal* (Water)**	Drinking water, drainage, flooding	Water conservation, test labs	Drinking water projects	Ground water depletion and subsidence	Ground water	Water saving technologies, waste water recycling	Municipal Water Supply, Bottle Water Companies	Clean rivers, groundwater recharge
***Jamin* (Land)**	Land-use, dust	Land-use, land protection	Open space, dust control	Congested living and public health	Land degradation	Green belt, lawn and grass cover	Soil Conservation Office, Land Office	Climate smart communities, recreational areas
***Jungle* (Forest)**	Urban trees, sacred grooves	Tree nurseries, parks, community forestry	Green city, sacred grooves	Forest and water resources	Forest species and wildlife	Urban tree management, soil erosion control	Municipality Office, Soil Conservation Office	Green environment, tourism development
***Jadibuti* (Medicinal and aromatic plants)**	Ayurvedhic medicine, herbs	Memory bank, remnants	Domesticating herbs, processing industries	Medicinal and aromatic plants and riparian buffers	Inventory of medicinal and aromatic plants	Medicinal and aromatic plant nurseries, chemical extraction	Department of Medicinal and Aromatic Plants, District Agricultural Office	Community gardens, tourism, Plant ID tours

***Janshakti* (Manpower)**	Education, capacity-building, employment	Schools, training centers	Public education, private schools	Education and employment	Education and ethnicity	Teaching practices, online education	Department of Education, Municipal Government	Practical education, employment
***Janawar* (Animals)**	Dairy, pets, chicken	Market, veterinary services	Commercial production, collection centers	Climate change and livestock	Livestock productivity	Sustainable livestock production, organic production	Department of Agriculture, Veterinary Services	Income generation, import substitution
***Jarajuri* (Crop plants)**	Vegetable production, organic produce	Market, technical assistance, IPM	Commercial production, loans	Soil condition and crop productivity	Crop productivity	Sustainable crop production technologies, fertilizer	Department of Agriculture, Cooperatives	Income generation, employment
***Jalabayu* (Climate)**	Drought, rain events	Flood control, crop diversification	Climate-smart agriculture, flood	Climate change and wildlife	Climate change impacts	Climate-smart agriculture, drought resistant varieties,	Department of Meteorology, Municipality Office	Climate resilient communities, resource conservation

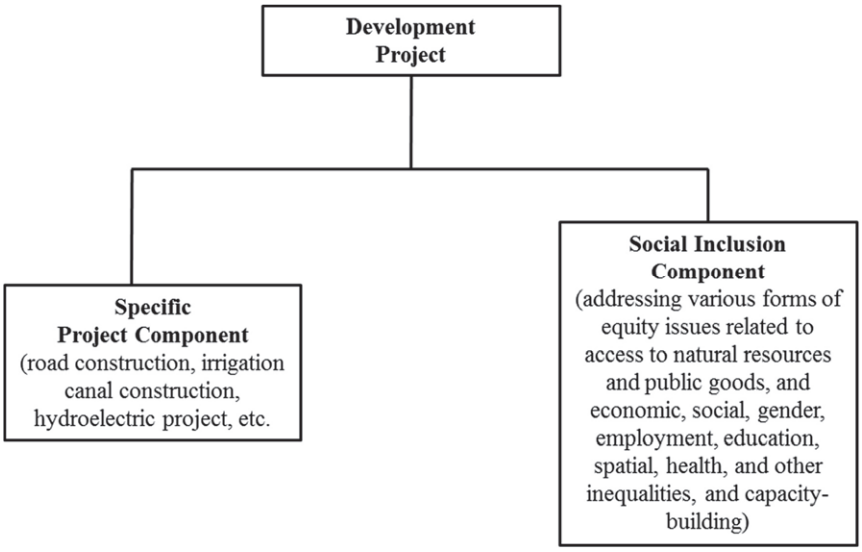

Figure 13 Incorporation of Social Inclusion Component in Developmental Projects, (adopted from Poudel, D.D. 2021b. Social Inclusion, Sustainable Development and Asta-Ja in Nepal, Figure 1, In: Medani P. Bhandari and Shvindina Hanna (Editors), Inequality-The Unbeatbale Challenge, River Publishers Series in Chemical, Environmental, and Energy Engineering, ISBN: 978-87-7022-623-3 e-ISBN: 978-87-7022-622-6 [In Press]).

Social inclusion projects require sustained funding, which should come directly from the governmental sources ensuring that funds are available in a regular basis. Each community possesses specific social inclusion issue. Therefore, social inclusion policies that are vague and too broad are difficult to translate at the local level. Local authorities in participation with local communities should come up with their own social inclusion issues that need attention. Many multilateral development aid agencies have started incorporating gender equality and social inclusion element in their developmental programs (ADB, 2010). The Government of Nepal should also incorporate social inclusion component in its all development projects to expedite the process for the alleviation of social and economic inequalities. A district-level Social Inclusion Authority (SIA) (Figure 13) will be necessary for coordination and implementation of these activities. A developmental project whether it is highway construction, irrigation, drinking water project, or any other that comes from governmental funding should allocate certain amount of its budget for social inclusion component in SIA budget. These funds could be used for community capacity-building projects such as housing, education,

health support, relief funds, natural resources conservation, etc. Funds from SIA can also be disbursed to needy members and families in the community for family support, business promotion, education support, scholarships, and for any other support. The Board members who oversee SIA should be the representatives from all quarters of the community.

Social inclusion and community capacity-building projects need robust monitoring, evaluation, and reporting. It is necessary to identify project measures that are not working properly as early as possible for timely necessary adjustments. According to Black (2003), community capacity-building efforts should be assessed based on values it promotes in the community, the impacts it makes at the grassroots level, whether the poor and marginalized populations are strengthened, and whether it imparts equity and justice on the overall population, rather than simply meeting its stated aims and objectives. Asta-Ja Framework's in-depth community capacity-building project's monitoring, evaluation, and reporting scheme is presented in Figure 14.

Community capacity-building and social inclusion is a long-term process. As local communities have multitudes of problems to tackle and resources are limited, priorities should be set for resource allocation. A long-term commitment from governmental agencies, community-based organizations, local communities and other stakeholders is necessary to make community capacity-building and social inclusion projects successful. As shown in figure 14, it is important to clearly identify and define the six elements of community capacity-building, i.e. inputs, process, outputs and outcomes, performance, impacts and reporting. While the element of "inputs" include natural resources such as land, forests, and streams; human resources, organizational involvement, volunteerism, etc., the "process" include community capacity-building activities and functions such as community trainings, policy decision-making, workshops and conferences, research, advocacy, networking, and community mobilization (Poudel, 2012a). The "outputs and outcomes" of community capacity-building include trainings completed, leadership developed, public outreach, natural resource management such as flood protection or planting trees, adoption of best management practices, changes in management practices, etc. Community capacity developed for designing and implementing programs, managing financial resources, technology transfer, changes in attitude and behavior, and the assessment of outputs with respect to program goals and objectives include the "performance". The element of "impact" includes the actual change in people's well-being and the environment. An increase in household income, higher

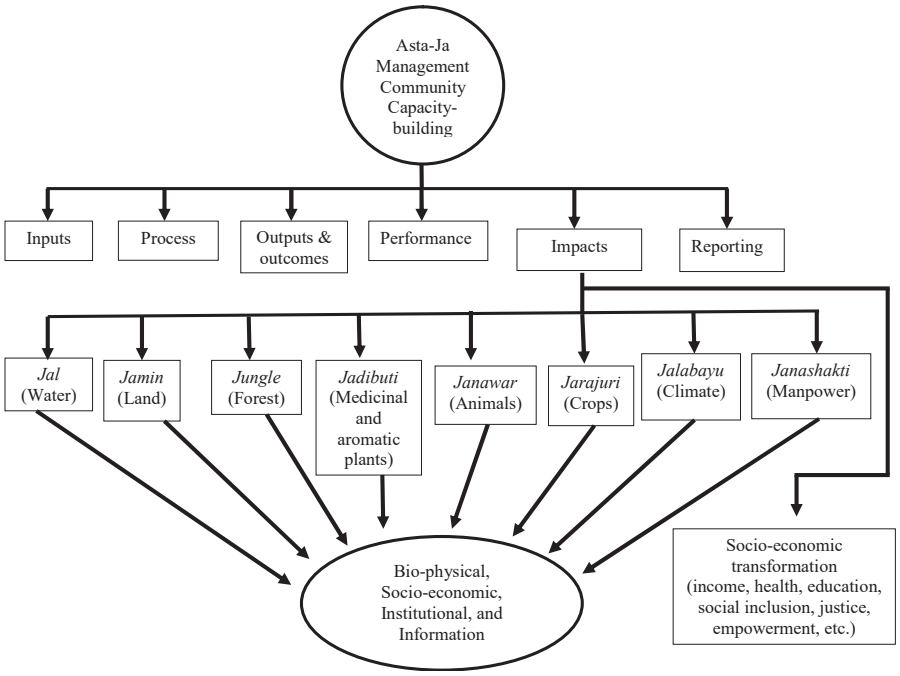

Figure 14 Asta-Ja management community capacity-building monitoring, evaluation, and reporting (adopted from Poudel, 2012a. The Asta-Ja Management Capacity-building Framework for Sustainable Development in Nepal, *International Journal of Sustainable Development,* Vol. 15, No. 4, pp. 334–352. Figure 3, Page 346).

level of health status, and increased education level indicate change in the socio-economic conditions of the people. The impacts of community capacity building projects should be assessed with system's perspective. This can be done by considering impacts on biophysical, socio-economic, institutional, and informational aspect of Asta-Ja resources (Poudel 2012a). While factors such as climate and soil characteristics, crop production, livestock development, pasture management, water quantity and quality, forest conservation, and wildlife and habitat, etc., include the bio-physical aspects of Asta-Ja resources, factors such as income generation, ownership of the resources, policies and institutional development, and the development of community organizations for resource conservation include its socio-economic dimension. Institutional aspect of Asta-Ja resources includes policies and guidelines, governance, ownerships, trade, market, etc. Similarly, informational aspect of Asta-Ja resources include data collection, storage, analyses and

reporting, and information dissemination. The "reporting" component of the Asta-Ja community capacity-building framework requires the development of comprehensive reports for each community projects and their distribution.

Alleviation of social discrimination and inequalities require the formulation of equitable policies and programs and the implementation of activities that impact positively to diverse communities and individuals in a society. It is important to develop a strategic plan for alleviating social and economic inequalities and prioritize resource allocation for community capacity-building promoting diversity, inclusion and equity. Asta-Ja Framework embraces the essence of *Vasudhaiva Kutumbakam,* meaning, "the world is one family", a very common and powerful phrase from Hindu Upanishad when expressing views on global harmony. Many scholars have written extensively on *Vasudhaiva Kutumbakam* (Bhandari, 2019b, 2019c; Vivekananda International Foundation, 2019). Bhandari (2019b) argues that the successful address of social, environmental, and climate change problems requires the mindset and perspective of *Vasudhaiva Kutumbakam*. Furthermore, Asta-Ja Framework echoes famous universal welfare phrase from Hindu Upanishad "*Sarve Bhavantu Sukhinah, Sarve Santu Niraamayaah, Sarve Bhadraani Pashyantu, Maa Kashcid-Duhkha-Bhaag-Bhavat*" meaning, "Let all be happy, Let all be healthy, May all see what is auspicious, and May no one suffer in any way". The issue of social inclusion needs to be taught in schools and colleges, be considered as a key issue for social development, and social inclusion projects need higher funding priorities without any prejudice and skepticism. Asta-Ja Framework recognizes diversity, inclusion and equity and strives for community capacity-building from bottom-up as a way for alleviating social and economic discriminations and inequities in the society.

Conclusions

Nepal is endowed with vast natural resources (e.g. water resources, forests, fertile land, animals, medicinal and aromatic plants, and climate) and hard-working human resources. Nepal's food production system has evolved through millennia and the country had been self-sufficient in food until 30 years ago. Nepal is known for natural beauty and its pristine environment. However, in recent decades Nepal is struggling with food, water, climate and environmental insecurity, increasing agricultural imports and widening trade gaps, massive outmigration of people to foreign jobs, skyrocketing public debts, and increasing income gaps. Food, water, climate and environmental

security, economic growth and employment generation, and social inclusion have become the most pressing needs and challenges for Nepal. In order to address this multifaceted problems and challenges effectively and realize accelerated economic growth and fast-paced socio-economic transformation, Nepal urgently needs a comprehensive developmental framework. The Asta-Ja Framework, which is a theoretically grounded, comprehensive, grassroots-based, is a peaceful planning and development approach focusing on the conservation and development of natural and human resources on the basis of competitive advantage to realize food, water, climate and environmental security, economic growth, and social justice. The eight principles of the Asta-Ja Framework include raising community awareness, community capacity-building, policy decision-making, understanding linkages among Asta-Ja elements, assessment, development of sustainable technologies and practices, governance and sustainable community development. The Asta-Ja Framework offers practical guidelines for gearing nation to its fast-paced socio-economic transformation. Nepal has competitive advantage on wide range of enterprises and activities including organic agriculture, off-season/in season fruits and vegetables, vegetable seeds, other high-value agriculture, tourism, hydropower, medicinal and aromatic plant industries, and biodiversity. Through Asta-Ja community capacity-building process, the Government of Nepal can reach to marginalized and poverty-stricken population effectively in addressing their socio-economic problems. Asta-Ja Framework is well accepted in Nepalese society. There is also a great deal of synergy between the UN's 2030 SDGs and the Asta-Ja Framework. The Government of Nepal is suggested to adopt Asta-Ja Framework as its national planning and development framework for food, water, climate and environmental security, sustainable economic development, and alleviation of all forms of inequalities and inequities in the society.

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