

Spatial Database for Environment Studies of Projects

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1. ABSTRACT:-

Key words: Digital mapping, aerial/satellite imageries, TOR, EMP, RAP

It is compulsory to carry out preliminary, Environmental Assessment, Environmental Impact Assessment (EIA) or Initial Environment Assessment (IEA) prior to implementation development programs in Nepal. Environmental protection Act 1997 and Rules 1998 of Nepal and guidelines of major multinational financial institution like ADB, WB guidelines will provide guidelines on assessment and mitigation on environment effects. These regulations specify the areas of works and do not describe requirement of the spatial data base.

It involves preparation of terms of reference (TOR), scoping documents, Environment Management Plan (EMP), resettlement action plan (RAP) and monitoring framework to effective monitoring at the implementation phase and carry out base line survey, qualitative and quantitative analysis, social impact assessment (SIA). The major task is also land acquisition for the projects.

Digital topographical maps are proposed for the project areas at 1:500 – 1:10,000 (point clouds for 5m to 100 m interval), digital cadastral map at the scale of 1:500 – 1:2500 and present land use maps are prepared using aerial/satellite imageries of about 0.5 or better resolution. Base line survey is carried using questionnaires of all affected land owners along with FGD survey method. Extensive field visit was carried out by experts and their environmental and social impact assessments described in the reports. Various experts present their findings in verbal texts but they could be easily presented in GIS formats/spatial data base, which are easier to understand the situations.

In this article, it is briefly described how the various works of EIA/IEA and SIA are carried out, specify minimum data base and the available spatial data base will be utilized for proper environmental assessments and monitoring, and acquisition of real estate property smoothly for the project.

2. BACKGROUND

UN agencies, World Bank, Asian Development Bank, etc decided to carry out environmental and safeguard in 1960-70 studies compulsory to implement large construction projects. Nepal government in sixth Plan Period (1980-85) and government also initiated environment studies by creation and establishing of Soil Conservation Department in 1982 to develop necessary instruments for integration EIA in infrastructure development projects. It promulgated Environmental Impact Assessment, Guideline in 1993, Environment Protection Act (EPA) in 1997 and Environment Protection Rules (EPR) 1997 enforced since June 1997. Nepal is also required to fulfill the Sustainable Development Goals 2030. Nepal is also hotspot of

biodiversities as it has 60m to 8850m elevation variations with natural habitats of many species. It was settled over 72000 years. These earlier culture, relics required to be conserved for future generation. It has twelve written scripts and over 120 languages required to protect. Nepali language is one of the major languages of SAARC Region which needs to enhance perpetually.

About 18 percent of citizens are in absolute poverty and backward cultural practices. It needs to address and irradiate property and backwardness.

The massive constructions or development of infrastructures are being implemented which may effect the environment and eviction of people from their traditional land. It will also employ many people and need heavy machinery during construction. Land acquisition is major problem in Nepal. During the maintenance phase, it needs to look after the environmental situations.

Spatial data created during design phase. They are topographical, geological and geophysical and climatological data and socio-economic studies. Satellite/aerial imageries are also available. Hand held GPS receiver may used to locate existing structures and biodiversity areas. Half of districts cadastral survey maps of Nepal are based on national control network which could be overlay on engineering designs.

3. INTRODUCTION

The work environmental impacts and safeguard studies are depended upon the size of project and nature of the impact. They are Environmental Impact Assessment (EIA) and Initial Impact Assessment(IEA). They are defined by Environmental Protection Act,1997 (EPA) & Environmental Protection Rules,1997 (EPR) and Environmental Protection Guidelines 1993. The major activities of the studies are as following:

The Environmental Impact Assessment of the development or hydropower project is to conduct with the requirements of the Government of Nepal, Environmental Protection Act,1997, Environmental Protection Rules,1997(with amendments), and guidance as well as major multinational financial institutions like ADB, WB latest guidelines with regard to environmental protection and resettlement.

The major activities regarding the environmental impact and safe guard studies as relevant Nepalese laws and regulations shall include but not limited to the followings:

- a) Prepare the **Terms of Reference (ToR) and Scoping documents** as per the Environment Protection Act-1996, Environment Protection Rules-1997 and above mentioned guide- lines. Before proceeding with the EIA, the ToR and Scoping documents need to be approved by the Ministry of Forest and Environment, Nepal.
- b) Carry out the **baseline survey in the entire project area**. This shall include , among others, collecting and updating information on flora, fauna, residents, houses,

infrastructures, culture and tradition, ethnic communities, water quality, pattern of agriculture, economic activities, pattern of settlements etc.

c) Conduct a detailed **qualitative and quantitative analysis** of the anticipated changes to the base line to determine the direct, indirect, induced and cumulative impacts of the project in construction, operation and maintenance phases. These impacts may include, but not limited to, loss of Habitat and ecosystems, Hydrological changes, loss of flora and fauna, impacts on wild life, food supply chain and migration patterns of wild life, water quality ,emission of greenhouse gases, erosion and sedimentation, loss of physical and cultural resources, impacts associated with construction etc. The Consultant shall pre- sent the analysis and the results in appropriate form.

d) Conduct **Social Impact Assessment (SIA)** of the project with reference to the following:

Identify permanent and temporary socioeconomic impacts arising from land acquisition, changes inland use, and restrictions of accessories a result of construction of the project facilities, including measures to minimize the number of affected land users within the river catchments including upstream and downstream areas. The consultant shall identify and evaluate social and economic impacts resulting from project implementation, including but not limited to, the types of social impacts, the extent and severity of these impacts (construction are as; quarry areas, spoil disposal areas, construction camps, community resettlement areas, access roads, power transmission Line/corridors).

e) Prepare the following Environmental and Social Management Plans:

i. **Prepare Environmental Management Plan(EMP)** covering, but not limited to, the following:

Erosion and sedimentation control, spoil disposal and management, quarry management, water quality ,reservoir clearance, chemical and used oils and lubricant waste management, Hazardous materials, emission and dust control, noise control, physical cultural resources, vegetation clearing, landscaping and re-vegetation, solid waste management, use of explosive materials, and any other construction related issue

The measures for management of social impacts shall include, but not limited to management required to mitigate the impact due to change in land use patterns, employments, compensations, water quality, seasonal flooding, soil degradation, and bank soil stability /erosion and land use changes , fire Hazards, river transportation, inundated forests, impediments to movements of animals, cattle, people, and disruption of communication between communities, loss of land, land disputes, increased flooding, water borne diseases, loss of social fabrics, negative

impacts on fishing activities, inability to afford new technologies and impact on ritual sites.

Management of operation related impacts which shall include reservoir inundation, water quality, riparian release and management of other identified impacts relevant to the operation and maintenance stages.

ii. Prepare a **Resettlement Action Plan (RAP)**, and an Indigenous/Vulnerable People's/Community Development Plan (IPDP/VCDP) as part of Social Management Plan (SMP) with full participation of stakeholders. The plans shall, among others, include the following:

Full census and inventory of lost assets/households (permanent or temporary),

Indicating the scope and magnitude of likely resettlement effects, and list likely losses of house holds, agricultural lands, business and income opportunities, as well as affected communal assets and public buildings;

An entitlement matrix, listing all likely effects, such as permanent and or temporary land acquisition, and a study to determine the replacement costs of all categories of losses based on the asset valuation process, with particular attention to vulnerable groups including indigenous peoples, women, children and the poor and socially excluded;

Cost estimates and clear budgets for land acquisition and resettlement cost with a specific sourcing and approval process;

Project specific social and gender action plan including rehabilitation of rural infrastructure, livelihood –related activities, and any specific training or awareness programs for local communities and vulnerable people such as women and the socially excluded. The action plan shall include the cost and the checklist for monitoring the base line data in the plan.

An implementation schedule consistent with all the resettlement plan requirements, making sure that major components are carried out before the Civil works

Social action programs; and

Implementation plans for land purchase and acquisition, payment of compensation, livelihood restoration programs, and community development plans.

iii. Prepare **Detailed Monitoring Framework** to effectively monitor the implementation of various plans during construction and operation phase

f) **Assess the capacity of the executing and implementing agencies** to plan, manage, implement, finance, and monitor, and prepare capacity-building measures and training workshops for stakeholders.

g) **Organize public hearings** (at least two) in project affected area to discuss all the assessment done and mitigation measures suggested

h) Finalization of these safeguards documents (resettlement action plan, indigenous people plan, environmental management plan, addendum of EIA, appropriate monitoring plan) in line with other major multinational donor agencies' Guidelines.

The impact of the project will have far away from the railway head to the project site. It needs to improve road network to the project site and produce construction materials like cement, steel rods, production or supply of additional electricity, water supply and other infrastructures.

The affected persons needs to resettle and reconstruction of affected institutional building, road, infrastructures, and other facilities.

4. DATABASE

Topographical maps/ digital data available at the scale of 1:25,000-1:50,000 with contour vertical interval of 5m-40m of Nepal and land Resources map at the scale of 1:10,000- 1:50,000 or smaller scales. Control points available at 5km interval and BM located along the main highway at 2km interval. Some control points of 16 district was affected by destructive earth quake of 2015 are being restored. Cadastral survey of Nepal conducted in 1964-98 at the scale 1:500-1:4800 covering all the cultivated land at the time of cadastral survey. They need to upgrade as per the development. Lidar survey of Nepal at 15cm resolution is being carried out.

Map projection and coordinate system is modified universal meridians Mercator projection (MUTM) with coordinate of central meridians (81° 84° & 87° E) 500,000m and 0m at equator. The central scale factor is of 0.9999. Map sheet No. of project area are also same as cadastral maps.

Most of the project area maps where prepared at the scale of 1:500 -1:1000 of the main area or dams and power house site and other sites at the scale of 1:5,000/1:10,000 such as of reservoir, tunnel axis. These maps are digital maps and hard copy are prepared and printed in paper from pdf file.

Hand held GPS instruments could be used in the field to record the position (x, y, H) and take a photo of the site of socio economic surveys. It is also used to reach the prescribed location and record the tentative coordinates. Spatial database and GIS is extensively used in project planning and design in Nepal. Environment Management system (EMS) is developed in 1990s and uses ISO standard 14001. It is a system and data base which integrate procedures and processes. There are also Environment Data Management system (EDMS) and Environment Management Information System (EMIS).

5. LEGAL PROVISIONS

UN agencies, World Bank (WB) and Asian Development Bank (ADB) prepared guidelines to their funded projects which including study compulsorily the environment and social safeguard studies and transparent procurement of services.

The Government of Nepal (GoN) has a well-established legal framework for environmental assessment of development projects. The most relevant national policies, acts and guidelines of the GoN concerning environmental management, which are relevant to the proposed project, are listed as follows

1. Constitution of Nepal,
2. Muluki Devani Sanhita Ain, 2017
3. Fourteenth Plan 2016-2019
4. Hydropower Development Policy 2001
5. Rural Energy Policy 2006
6. Land Acquisition, Resettlement and Rehabilitation Policy 2015
7. National Environmental Impact Assessment Guideline 1993
8. Environment Protection Act 1997
9. Environment Protection Rule 1997
10. Electricity Act 1992
11. Water Resources Act 1992
12. Hydropower Environment Impact Assessment, July 2018, Min. of Forest and Environment, Nepal.
13. Environment & Social Management Frame work, July 2018, Min. of Energy wall Resources & Irrigation.
14. Land Acquisition Act 1977
15. Land Revenue Act 1977
16. Labour Act, 2074
17. Local Governance Operation Act 2017
18. National Parks and Wildlife Conservation Act 1973
19. National Foundation for Upliftment of Aadibasi/Janjati Act, 2002
20. Forest Act 1993
21. Forest Rules 1995
22. Child Labor (Prohibition and Regulation) Act 2000
23. Ancient Monuments Preservation Act 1956
24. Buffer Zone Management Regulation 1996
25. Royalty and Benefit Sharing Mechanism

3.2 International guidelines:

1. International Convention on Biodiversity 1992
2. Convention on International Trade in Endangered Species of Wild Fauna and Flora 1975
3. Environment Assessment Guidelines. 2003, Asian Development Bank (ADB) .

4. Guidance Notes for Borrowers June 2018, World Bank (WB).

6. WORK AND DATABASE

The works are summaries as preparation of TOR, scoping document, EMP, RAP, and monitoring frame work and carryout base line surveys, qualitative and quantitative analysis, SIA and Land Acquisition.

The legislation Environment Protection Act 1997 and Environment Protection Rule 1997, and Hydropower Environment Impact Assessment Manual, July 2018 describe spatial data as following:

1. Constitution of Nepal, Constitution of Nepal states in policies of state- policies relating to protection, promotion and use of natural resources
2. The Environment Protection Act 1997 Annex 6, Para 14, maintain the document are required to submit as:

- (a) Maps –Topographical, physical position, land use, land capability, and other maps related to study.
- (b) Aerial photos
- (c) Questionnaire & subject list
- (d). Chart and sketches related to E.I.A
- (e) Other data

3. Similarly. Hydropower Environment Impact Assessment Manual, 2018, Annex A - Base line study parameters and study methodology for Hydropower project (p 75) also maintain the use of satellite imagery and other data as per the Table 1.

The legislation specify the area of works without spatial data. There is no clear description of spatial data base on the legislation and most of reports are merely verbal description and photos of environmental situations.

The main objective of is to provide minimal spatial data base required for these environmental studies. Cadastral data/ maps are extensively used for evaluation of economic situation and land acquisition.

The following Table1, which further extension of , is proposed to minimum spatial data base used in the situation of Nepal.

Table 1: Minimum Spatial Data

Environment aspect	Min Baseline Survey parameters	Source/ Method of data Collection	Use in EIA. IEE	Spatial Data
Weather and climate	Temperature Precipitation Humidity Evapotranspiration Wind direction Atmospheric pressures	Department of Hydrology and Meteorology (DHM) provides data on climate and weather Project Feasibility Study Report would contain information on historical weather and climate data as basis for assessing hydropower potential Secure 30-year average climate data from the DHM Secure Rainfall Intensity-Duration-Frequency (IDF) curves from DHM	Data will be used for characterizing existing weather and climate patterns within the study areas. Information will be used for hydrologic modelling.	Data presented in 1: 25,000 Or 1: 10,000 maps with coordinates of stations
Hydrology	Major rivers Average flow Maximum flow Other water resources	Stream flow data from DHM at certain sections of river (e.g. upstream of the weir or dam, downstream of powerhouse, and midstream of weir/dam of powerhouse) Project Feasibility Study Report would contain information on streamflow data used for investigating hydropower potential Secure/measure daily streamflow data at certain sections of the river; if not available, use suitable methods to calculate streamflow (e.g. rainfall-runoff method) Records of historical floods during extreme weather conditions and occurrence of glacial lake outburst floods (GLOF), ICIMOD	Information will be used in characterizing streamflow at certain sections of the river for hydropower development. Historical streamflow data will be used for hydrologic and hydraulic modelling of instream flow changes. Streamflow information will be used in analyzing aquatic habitat characteristics and water quality data.	
Sedimentation	Sediment load concentration	Determine sediment load concentration at certain sections of the river in relation to proposed location of the hydropower facilities (i.e. weir, intake structure, powerhouse, etc.)	Sediment load will be used in hydrologic and hydraulic modelling to characterize river flows and aquatic habitat and future scenarios	

			when hydropower plant becomes operational	
Air	quality Nitrogen oxides (NOx) Carbon monoxide (CO) Sulfur oxides (SOx) Particulate matters (total suspended particulates, PM10, PM2.5)	Ambient air monitoring compared to Nepal Ambient Air Quality Standards 2012 (2069 B.S.) and standard limits of ambient air quality parameters around construction sites Measurement, analysis with calibrated equipment (air quality parameters, including volatile organic compounds (VOCs) and benzene)	Establish baseline ambient air quality to assess whether construction activities are likely to impact ambient air quality.	
Noise	Ambient noise level Equivalent noise level	Ambient and equivalent noise levels compared to Nepal Noise Standards 2012 (2069 B.S.) Noise levels for different land use categories and noise generating equipment Measurement, analysis with calibrated equipment (sound level)	Establish baseline ambient and equivalent noise levels to assess whether construction and operational activities of hydropower development are likely to impact nearby sensitive receptors.	
Water quality	Surface water quality parameters (including testing of dissolved oxygen, turbidity, total suspended solids, dissolved oxygen, conductivity, total nitrate, etc.) Groundwater quality compared to drinking water standards (including testing of dissolved oxygen, total suspended solids, conductivity, total nitrate, etc.)	Comparison of water quality parameters against Nepal Drinking Water Quality Standards, 2005 (2062B.S.) Establish water quality of identified source/s of drinking water supply in project camps and construction sites Compare drinking water quality standards against National Drinking Water Quality Standards, 2005 (2062B.S.)	Establish water quality of surface water and sources of drinking water supply for construction camps and water to be used for construction and operation of the site office.	
Geology,	geomorphology, soils, and natural hazards Rock and soil type Geological formation and structure,	Geological maps, engineering geological maps Aerial photographs Site walkthrough and observation	Establish baseline information on geology, geomorphology, soils, and	

	<p>lithology, attitudes of beds and discontinuities</p> <p>Occurrence of landslides</p> <p>Potential for debris flow</p> <p>Potential occurrence of GLOF</p> <p>Location of active faults</p> <p>Soil erosion potential</p> <p>Seismicity</p>	<p>Geotechnical investigation based on Detailed Project Report</p>	<p>natural hazards as basis for safety engineering design criteria.</p> <p>Site specific risks, including but not limited to seismic activities, GLOF, slope stability, soil erosion, and other dynamic loading, in relation to construction and operation of hydropower project facilities should be established.</p>	
Land	<p>Land use</p> <p>Use of natural resources</p> <p>Topography</p> <p>Land cover (i.e. types of agricultural lands)</p>	<p>Land use map</p> <p>Topographic map</p> <p>Field walkthrough</p> <p>Aerial photographs</p> <p>Satellite images</p> <p>GIS maps</p> <p>Google ® images</p>	<p>Establish land use and classification and identify potential conflict or encroachment on land use.</p>	
Watershed	<p>Soil erosion potential</p> <p>Identify water sources such as springs, wetlands, catchment area etc.</p> <p>Delineate area of the watershed or catchment area</p> <p>Characterize existing condition of the watershed (i.e. determine protection status, regulatory mandate, etc.)</p> <p>Watershed hotspots</p>	<p>Soil loss estimation</p> <p>Measurement of degraded land area as shown on a map</p> <p>Soil erosion potential map</p> <p>Watershed</p>	<p>Establish existing baseline condition of the watershed or area of influence of the hydropower project to be able to assess potential impacts of the project on existing resources</p> <p>Also refer to “Biological Environment”</p>	
Flora (terrestrial and aquatic) *Also refer to fishery and aquatic ecology	<p>Forest type</p> <p>Forest management type: community, private, religious, lease-hold, government</p> <p>List of major plant species (protected species, endemic species, non-timber forest products)</p> <p>Ethno-botanically important</p>	<p>Field investigation, sampling, inventory and identification</p> <p>Herbarium collection and identification</p> <p>Nepal national inventory</p> <p>Interview with local community</p> <p>Site visit and observation</p> <p>CITES and IUCN lists</p> <p>Reports and periodicals from GoN.</p>	<p>Forest Sector Rules and Regulation of GoN</p> <p>Establish baseline data throughout seasonal variation and using secondary references and identify potential impacts of the hydropower project on critical habitats, flora and fauna.</p>	

	<p>plant species Aquatic plants Invasive species Agro-biodiversity Wildlife corridor Biodiversity hotspots Vegetation cover Medicinal plants</p>			
Fauna (terrestrial)	<p>Types of wildlife (including mammals, herpetofauna, entomofauna, reptiles, and their migration corridor) Avifauna (including migration patterns, particularly along/across project sites) Wildlife habitat and existing conditions</p>	<p>Field investigation using traps/nets, use of pellets, and appropriate techniques Interview with local communities Site walkthrough and observation (e.g. pug marks) Secondary data and CITES and IUCN lists Reports and periodicals from GoN. Forest Sector Rules and Regulation of GoN</p>	<p>Establish baseline information on terrestrial fauna</p>	
Fisheries and aquatic ecology	<p>Fish catch and species identified Fish movement or known migration along river and its tributaries Aquatic habitat status or existing conditions Status of resident and migratory fish Macro invertebrates including crustaceans, molluscs, aquatic insects Plankton and periplankton</p>	<p>Fish sampling Interview with fishermen Secondary data Field observation Meso-habitat survey Surber sampler Plankton net Appropriate fishing or netting technique</p>	<p>Delineate study area or area of influence (watershed, map of project key components, project type, and purpose). Identify areas likely to be affected (curtailed reach or section likely to experience reduced instream flows) Assess potential impacts of reduced instream flows on fisheries and aquatic ecology in general.</p>	
Demography	<p>Population distribution (age, sex, religion, population, population growth, migration patterns) Family and types Ethnic composition, vulnerable and marginalized groups Average household size</p>	<p>Rural Municipality/Municipality profile District profile CBS data Household survey Focus group discussion Key informant interviews Participatory rural appraisal or PRA</p>	<p>Establish baseline conditions of project affected families within area of influence and assess potential impacts on these stakeholder groups.</p>	

		Rapid rural appraisal or RRA		
Houses and	Settlement Types of houses and settlement pattern (nucleated, dispersed family), distance of settlements, ownership status, materials used for construction Total household Average household size	Rural Municipality/Municipality and municipality profile District profile Site visit and observations Focus group discussion Satellite images CBS data	Determine location of sensitive receptors, map project affected households within the project area of influence and assess potential impacts of hydropower development on these sensitive receptors.	
Education	Number and type of educational institutions Enrolment details Literacy rate Educational status (according to level of degree and age)	Rural Municipality/Municipality and district profiles Household survey Interview with stakeholder groups School records	Determine level of education of project affected families and identify potential and capacity to be employed during project development. Assess potential benefits project may bring to these project affected families.	
Health, sanitation, and hygiene	General health condition Types of prevalent, and new diseases (e.g. HIV/AIDS, STD) Status of communicable and non-communicable diseases Toilet and sewer facilities Sources and access to safe drinking water	Rural Municipality/Municipality and district profiles Household survey Interview, site visit, and observations Health posts, primary health care center, hospitals	Establish existing baseline conditions and identify avenues to prevent spread of communicable diseases during project implementation.	
Waste management	Existing waste management practices (e.g. landfill sites, hazardous waste	Rural Municipality/Municipality and district profiles Household surveys	Establish existing waste management practices and identify	

	management practices, wastewater treatment and disposal, solid waste management disposal practices)	Interviews, site visit and observations Focus group discussion	options for properly managing and disposing of wastes during construction and operation phase	
Physical / Community	bridges Existing power sources and facilities Communication (telephone, post office) Drinking water supply Market establishments Industry or factory Financial institutions (e.g. cooperatives, saving groups, banks) Police or security agencies Number of educational institutions Communication centers Water mills Micro-hydro facilities Irrigation supplies/ sources Recreational and religious sites (community common areas)	infrastructure Status of road and Rural Municipality/Municipality and district profiles Household survey Interview and conduct of focus group discussion Secondary sources	Establish baseline information to be able to identify potential social development programs to enhance existing conditions of project affected families within the area of influence.	
Economy	Sources of income and expenditure level Livelihood sources Employment and remittances Land ownership and tenure system Livestock practices Poverty status	Rural Municipality/Municipality and district profiles Household surveys Interviews, site visit, and observations	Establish existing baseline conditions of project affected families within the area of influence and identify potential opportunities to improve livelihood to support families, especially those to be resettled.	
Water use	Water use for agricultural purpose (e.g. rafting, swimming, household uses) Water use rights Water user groups Observations on upstream and downstream water uses	Rural Municipality/ Municipality and district profiles Household surveys Interview, site visit and observations	Establish river water users/uses to be able to assess potential impacts on these user groups and opportunities for them to benefit from ecosystem services.	

During socio-economic survey, surveyor, sociologist or enumerator will visit every household. It is easier to collect and record (x, y, H) coordinates for each households or feature with photography using hand held GPS receivers. The accuracy of observation is generally 5-10m which is sufficient to identify and mark environment and social features on maps or ortho photos.

Environmental Management System (EMS) or Environment Management Information System (EMIS) is being developed since 1992 in developed countries. It follows ISO 14001 standards.

7. CONCLUSION

It is required to understand effects of various infrastructure development, agriculture and forestry, industry, mining and other activities on environment and society. Present legislation needs to specify the requirements of spatial data required for assessment of environment and social impact. Similarly, social scientist, environment experts and surveyor required to train to use hand held GPS and ortho photos/ imageries to their works. Geomatic engineer/ surveyor be employed to use EMS/EMIS. The existing spatial data are being updated and upgraded in Nepal, EMIS must be developed to the international standard.

8. REFERENCES

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9. ACKNOWLEDGEMENT

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10. BIOGRAPHICAL NOTES

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