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LI-BIRD

Case Studies on Sustainable Livelihoods in Rural Areas of Nepal

Ecosystem Restoration and Conservation for Resilient Livelihoods in the Rupa Lake Watershed of Nepal

Images of Rupa Lake watershed landscape in mid-1980s (left) and 2020 (right)

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ABBREVIATIONS

BIC	Biodiversity Information Centre
BTRT	Begnas Tal Rupa Tal
CAS	Chinese Academy of Sciences
CBD	Convention on Biological Diversity
CBM	Community Based Biodiversity Management
CBR	Community Biodiversity Register
CBW	Community Based Wetland Management
CDCC	Community Development Conservation Committee
CEL	Climate, Ecosystem and Livelihoods
CFUG	Community Forest User Group
CTEVT	Center for Technical Education and Vocational Training
DFID	Department for International Development
DGIS	Directorate General for International Cooperation
FGD	Focus Group Discussion
GEF	Global Environment Fund/Facility
GoN	Government of Nepal
IDRC	International Development Research Centre
IEMP	International Ecosystem Management Partnership
IGSNRR	Institute of Geographic Sciences and Natural Resources Research
IUCN	International Union for Conservation of Nature
JSA	Jaibiksrot Samrakchan Abhiyan
KiDeKi	Kisan Dekhi Kisan Samma (Farmer-to-Farmer)
KII	Key Informant Interview
LCPV	Lake Cluster of Pokhara Valley
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
LPG	Liquefied Petroleum Gas
LULC	Land Use and Land Cover
MDD-W	Minimum Dietary Diversity for Women
MEA	Millennium Ecosystem Assessment
NARC	Nepal Agricultural Research Council
NEDA	The Netherlands Development Assistance
NGO	Non-Government Organization
NPR	Nepalese Rupee
PPB	Participatory Plant Breeding
PRA	Participatory Rural Appraisal
RLRFC	Rupa Lake Restoration and Fishery Cooperative
RRA	Rapid Rural Appraisal
SDG	Sustainable Development Goal
SGP	Small Grant Programme of UNDP
SPSS	Statistical Package for Social Science
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention for Climate Change
VDC	Village Development Committee
VIF	Variance Influence Factor

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EXCUTIVE SUMMARY

This report presents findings of the case study of the impact of two initiatives implemented over recent past on local livelihoods in Rupa Lake watershed area, Nepal in the context of 'Climate Change, Ecosystem and Livelihood (CEL)' nexus, and assess the suitability of Rupa watershed experience for replication more widely. The CEL programme is a major initiative led by UNEP-International Ecosystem Management Partnership (UNEP-IEMP) and supported by China and other developing countries to promote long-term South-South Cooperation. The programme aims to assist the developing countries in delivering the Sustainable Development Goals (SDGs) and climate targets while protecting the ecosystems and improving rural livelihoods. Nepal is one of the three countries/sites selected for the case study. The other countries/sites include Southeast Asia and Southwest China.

The Study Site – Rupa Lake Watershed in the Nutshell

The Rupa Lake watershed area was chosen as a demonstration site for the case study because this is an area where a number of organizations, including Local Initiatives for Biodiversity, Research and Development (LI-BIRD – who implemented the case study), had implemented a number of projects in the past with the overall objective of restoration, conservation and utilization of Rupa Lake ecosystem and agrobiodiversity for resilient livelihood outcomes.

Located in Kaski district of Gandaki province, approximately 200 KM west of Kathmandu, Rupa watershed area covers 2,707 ha with altitude ranging from 580 to 1,420 MASL. Of the total area, 33.57% is agricultural land, 61.85% forestland, 3.69% water bodies, and 0.89% barren land. Some 1,185 households (5,332 people) of various caste and ethnicity live in the watershed area, of which 51.4% are female. Agriculture is the main source of livelihood. The watershed inhabitants draw income both from on-farm and off-farm employment. The climate is sub-tropical and humid, and is marked by monsoon rainfall. The average total precipitation over the period of 25 years (1985-2010) is 3,474 mm with an average of 128 rainy days (DHM/Nepal, 2015). Over a period of 30 years (1981-2011), the maximum and minimum average temperatures have increased by 0.810C and 0.20C respectively (Dixit et al, 2014).

Among the Rupa watershed's special features include its beautiful landscape with stunning panoramic view of the Himalayan mountain range. The Rupa watershed is also a part of the Lake Cluster of Pokhara Valley (LCPV), involving nine Lakes, and the area is recently designated as 10th Ramsar site of Nepal. Rupa watershed area comprises three distinct ecosystems: agriculture/agro-ecosystem; forest ecosystem; and wetland ecosystems, and provide a range of services (provisioning, regulating, cultural, etc) critical for sustaining local livelihoods. These ecosystems have gone through periods of deterioration due to over use and lack of appropriate management regime.

Projects/Initiatives Implemented to Build Resilience

In the past decades, six projects were implemented in the Rupa Lake watershed area. These included: (i) Begnas Tal Rupa Tal Watershed (BTRT) Management Project (1985-1998) funded by DGIS Netherlands and Government of Nepal (GoN), and implemented by CARE Nepal; (ii) Strengthening the Scientific Basis of In-situ Conservation of Agricultural Biodiversity On-farm Project (1997-2001) funded by NEDA Netherlands, IDRC Canada and Bioversity International, and jointly implemented by LI-BIRD and Nepal Agriculture Research Council (NARC); (iii) Community Biodiversity Register Project (2003-2005) funded by UNDP/GEF-SGP, and implemented by LI-BIRD; (iv) Community Based Wetland

Management Project (2006-2007) funded by IUCN, and implemented by LI-BIRD; (v) Enhancing Benefits to Smallholder Farmers by Linking Agrobiodiversity to Niche Market Project (2007-2011) funded by NORAD and implemented by LI-BIRD; and (vi) Mobilizing Local Resources and Institutions for Integrated Management and Utilization of Watershed Services in the Mid-Hills of Nepal Project (2014-2017) funded by Swiss ReSource Foundation, and implemented by LI-BIRD.

The large majority of these projects were implemented through two local organizations knows as 'Rupa Lake Restoration and Fishery Cooperative (RLRFC)' and 'Jaibiksrot Samrakchan Abhiyan (JSA)' who are directly involved in the restoration, conservation and utilization of Rupa Lake ecosystem and agrobiodiversity surrounding Rupa Lake respectively. JSA was established in 2006 with the objectives to: (i) operate as an umbrella organization and support farmer groups on the conservation of and promotion of local crop varieties; (ii) enhance group members' livelihoods by supporting income generating activities; and (iii) raise and manage funds and establish linkage to seek support from various government & non-governmental organizations. Since then JSA is operating as an umbrella organization with 17 farmer groups, 1 community development committee, 1 NGO and 2 cooperatives, as JSA's members. RFRFC was established in 2002 with three objectives: (i) rehabilitation and restoration of the Rupa Lake; (ii) enhancing income/livelihoods of the cooperative members; and (iii) conservation of local wetland biodiversity. The main reason for the establishment of RLRFC was the rapidly declining condition of the Rupa Lake due to increased sedimentation and siltation, increased infestation of weeds and invasive species in the Lake, and rapidly declining fish production, thereby affecting the local livelihoods, especially the traditional fishing communities who depended on Lake fish for living.

Situation of Rupa Watershed Prior to Mid-1980s

The Rupa watershed inhabitants had, for generations, depended for livelihoods on integrated farming systems in which farmland, livestock, forest, and water resources were intertwined. They depended heavily on public forestland for firewood and timber for household use, and fodder for farm animals. By mid 1980s, most of the forest in the Rupa watershed area had been completely deforested due to over harvesting for fodder, firewood and timber for household needs and uncontrolled grazing. The loss of forest cover accelerated the process of soil erosion on the hill slopes, the frequency of land slides and flooding, thereby increased sedimentation downstream during the monsoon, while in the dry season, causing drying up of natural streams. Awareness and importance on the conservation of forest, wetland and lake ecosystem was negligible among communities. Similarly, the Rupa watershed farmers had already switched to the habit of using modern agricultural technologies such as improved crop varieties, chemical fertilizers, insecticides and pesticides. Flow of such modern agricultural input residues into Rupa Lake had increased greatly. Many local crop varieties were no longer part of the regular agriculture production system and their genetic resources were fast eroding. Some of the local crop varieties/landraces were at the verge of being extinct. The importance of agrobiodiversity conservation to sustain agro-ecosystem was poorly understood and applied.

Situation of Rupa Watershed Post 2010s

Over the years, following the above project interventions and the subsequent response of the local people and other spontaneous development, the entire landscape of Rupa watershed has been transformed. The deforested areas have been rehabilitated, and the natural streams restored, thereby enhancing the Rupa watershed's overall water recharging capacity. There is now regular flow of clean water from the steams, and the Rupa Lake is much cleaner. The previously disappeared wild plants, animals and birds have returned to the forest and wetland areas. The Rupa watershed inhabitants have now much greater understanding and knowledge of local biodiversity. Information on 440 local crop varieties, including 111 wild medicinal

plants, 92 wild food species, wild animals, birds and fish have been documented and displayed through the establishment of 'Biodiversity Information Centre (BIC)', which is visited by thousands of domestic and foreign visitors annually. The conservation and promotion of local crop varieties and their genetic resources has helped local farmers to enhance food and nutrition security. The commercialization and branding of local agrobiodiversity products through the development of value chain for selected commodities is helping local farmers to improve income. The Rupa watershed farmers are increasingly adopting ecological/environmental friendly agricultural practices. The use of chemical fertilizers, insecticides and pesticides has reduced, with increased use of compost/farm yard manure and bio-pesticides.

Methodology Adopted for the Case Study

LI-BIRD and UNEP-IEMP/IGSNRR-CAS team conducted a joint field visit in October 2019 and identified Rupa Lake watershed area as appropriate demonstration site for conducting the case study. Two local organizations i.e. RLRFC and JSA who are directly involved in the management of Rupa Lake ecosystem, and conservation and utilization of agrobiodiversity surrounding Rupa Lake respectively were selected. In this case study, RLRFC and JSA are regarded as two initiatives crosscutting the projects mentioned above, and therefore, the households covered by these two organizations formed the basis for planning and conducting the two case studies. The study was spread over the period December 2019 – June 2020.

The household survey questionnaire complemented by Focus Group Discussion (FGD) and Key Informant Interview (KII) comprised the primary instrument to elicit data from the respondents. In addition to the household questionnaire survey, another methodology known as 'process documentation' was also planned and executed. While the household questionnaire survey focused in areas and household served by RLRFC and JSA, the process documentation focused in the case study of the two organizations (i.e. RLRFC and JSA) themselves. The process documentation aimed at drawing information on the governance and organizational functioning of RLRFC and JSA to complement the analysis of causes and underlying mechanisms for the impacts on livelihoods. A total of 240 households (120 households each for RLRFC and JSA) were interviewed, with 99 (41%) male and 141 (59%) female respondents. For each case study, out of 120 sample households, 60 households (50%) were randomly selected from the list of shareholders and member households in RLRFC and JSA respectively. The sample households comprised as 'participant household' (treatment group), which indicated that these households have participated in project interventions and benefitted in some ways from their participation. Whereas, the remaining 60 households (50%) were randomly selected as 'non-participant household' (control group) from the list of households which were non-shareholder of RLRFC and non-member of JSA, but dwell in the given geographic location i.e. Rupa watershed area.

The data analyses for both case studies were conducted separately though identical analyses were run in both the cases, and results are presented and interpreted accordingly. The analysis of combined data of RLRFC and JSA (i.e. the whole group of 240 households) was also conducted. The study team used the DFID's sustainable livelihood framework as a guide to analyze the collected data, and therefore, the key findings and the analysis of causes and underlying mechanisms for the impacts on livelihoods are organized and presented along DFID's Sustainable Livelihood Framework i.e. livelihood capital → livelihood strategy → livelihood outcome.

Key Findings – Livelihood Capital, Livelihood Strategy and Livelihood Outcomes

Livelihood Capital

Amongst the five livelihood assets (natural, physical, human, financial and social capitals), we analyzed

how the endowment of these capitals differ between participant and non-participant households for two case studies. The difference in endowment of natural capital (agricultural land) is statistically non-significant ($p>0.05$) between participant (0.5 ha) and non-participant (0.5 ha) households for both the case studies.

The ownership of physical capital (house, *Ghaderi*[1] and agricultural land) reveals that house and agricultural land ownership is universal, however, ownership of *Ghaderi* (plot) is not common, with figure ranging from n=9 to 23 (i.e. 15% to 39%). The difference in value of physical capital (house and agricultural land) owned by participant and non-participant households is statistically highly significant ($p<0.01$), with participant households' assets commanding higher values. The difference is more striking in case of RLRFC with average value of house worth NPR 12,014,000 (USD 97,674; 1 USD = 123 NPR), which is 4.9 times more valuable than the one owned by non-participant households.

The analysis of human capital entailed exploring the educational status of economically active population (15-64 years) of sampled households. Education attainment follows a similar pattern for participant and non-participant population except in case of college education, where participant group has visibly higher attainment. Less than 5% of the economically active workforce are illiterate, another 14-18% have basic level education (up to class 8), 48-59% workforce has secondary education (up to class 12), and 19-32% has college/university education.

In financial capital, household members having bank account, savings in the bank, credit card, bank loan and the purpose of taking loan were analyzed. Access to banking service is close to 100% with commendable bank savings. With 44% and 55% households for RLRFC and JSA accessing loans respectively, there is not much difference between participant and non-participant groups in loan taking behaviour. Banks and cooperatives are equally approached by respondents for loans pertaining to building/buying a house, education of family members, starting or expanding businesses, daily household living expenses, etc.

Understanding the social capital entailed analysis of family genealogy, membership in different organizations, and the networks respondents maintained in diverse fields. Slightly over a third of respondents were able to provide positive response on family genealogy, with participant group having significantly higher positive response ($p<0.01$) in case of RLRFC, whereas the same was not true in case of JSA. Respondents have membership in multiple organizations, and there is a similar trend in membership between the two case studies. In general, participant households as compared to non-participant households have slightly higher number of average connections/social network as well as higher number of reporting households.

Livelihood Strategy

Comparison of livelihood strategy of participant and non-participant households entailed analysing households owning family business, on-farm labour and off-farm employment, and place of employment. In case of RLRFC, 53% participant households reported owning businesses while that number was limited to 28% for non-participant households, and the difference is statistically highly significant ($p<0.01$). In both the case studies, it's important to note that 19-36% (n=3/16 and 8/22) of these reporting households own second businesses indicating diversification of income sources. The average value of first business for participant households (n=32 and n=22) is worth NPR 2,444,000 (USD 19,869) and NPR 2,308,000 (USD 18,764) for RLRFC and JSA households, which represent 3.5 and 2.7 times more than the business owned by non-participant households respectively.

Livelihood Outcomes

Analysis of livelihood outcomes for participant and non-participant households comprised looking into:

[1] Plot of land located in the market center/township or its surroundings or along the road corridor, usually maintained for house construction or for sale, that fetch much higher price compared to normal agriculture land in the village setting or elsewhere.

income and expenditures; energy use for cooking; agrobiodiversity; food intake; ecosystem health; and perception about climate change. As a livelihood diversification strategy, household members not only engage in on-farm activities but they also engage in off-farm activities such as micro-businesses, services, wage labouring, and overseas employment. The cumulative household average income for participant households (RLRFC=NPR 1,621,000 and JSA=NPR 2,262,000) is 2.1 to 2.6 times higher than non-participant households, with remittance, business and off-farm income as main contributors. Considerable number of households earn income from agriculture and livestock but the amount is miniscule. The average income exceeds the expenditure by 1.4 to 3.2 times for different groups indicating households have savings. The overall expenditure pattern for two groups is similar.

Comparative analysis of energy use for cooking reveal that Liquefied Petroleum Gas (LPG), firewood and biogas are important as primary source of energy applicable for participant and non-participant households. The use of LPG as primary energy source for participant households (RLRFC=60%; JSA=30%) is comparatively higher than non-participant households (RLRFC=13%, JSA=23%), with major difference observed in RLRFC groups. Use of electricity as supplementary energy for cooking is gaining momentum in both the groups with passage of time. Some of the reasons for shift towards cleaner form of energy for cooking include more convenient to use, less pollution, increased household income and favourable government policy.

Farmers grow multiple crops on-farm, where vegetables is universally grown (RLRFC=116, 97% and JSA=113, 94%) followed by rice (RLRFC=104, 87% and JSA=98, 82%) and corn (RLRFC=97, 81% and JSA=101, 84%). The varietal diversity between the groups and study sites do not vary much because these sites lie within similar agro-ecological region (mid hills). Some crops with appreciable diversity include: vegetables (8 species/HH), spices (4 species/HH), fruits (3 species/HH) and rice (3 varieties/HH).

Among the food items, milk and milk products comprise the most frequently consumed item – 13 times in a week reported by 80% (RLRFC) and 90% (JSA) households. Other frequently consumed food items include green leafy vegetables, pulses, and other vegetables, which are consumed 7-9, 9-10 and 8-10 times, reported by 97-100%, 95-98% and 78-88% households respectively per week. Animal source of proteins including fish and eggs, are less frequently consumed by fewer households. Consumption pattern is similar for both the groups.

Improvements in ecosystem health is one of the major achievements of LI-BIRD's longer term engagement in the area. There is a clear pattern amongst the respondents that they have observed increased availability of ecosystem services across the board for all, but one indicators (i.e. irrigation water because the irrigation facility was built long before the stated timeframe). Comparative analyses of access to various ecosystem services by participant and non-participant households indicate that statistically significant differences occur for following services: access to crop genetic resources ($p<0.00$); recreational activity ($p<0.05$); and agro-ecotourism ($p<0.00$), with former faring better than their counterparts. The benefits accruing from interventions made on biodiversity conservation and watershed management extend way beyond the immediate benefits realized by the participating communities, indicating that biodiversity conservation and watershed management investments have value beyond the geographic boundaries of the projects.

Irrespective of their groups, respondents have similar perceptions regarding the frequency and intensity of extreme events in their locality. Extreme events such as drought, high and low temperatures, incidence of plant disease and insect pests, and invasive plant species have become more frequent and their impact has also intensified over the past 5-10 years. The monetary damage incurred at household level from these extreme events is not considerable. In terms of mitigation measures practiced by respondents, the measures adopted were few suggesting that they don't have robust combat mechanism.

Causes and Underlying Mechanisms for the Impact on Livelihoods

Strengthening Livelihood Capitals: Basis for Household's Livelihood Strategy and Outcomes

For understanding the causes and underlying mechanisms for the impact on livelihoods, the household survey findings need to be viewed in the context of the project initiatives to build resilience, particularly situation of the Rupa watershed area prior to the project interventions i.e. mid-1980s (Section 3.2) and the situation of Rupa watershed post 2010s (Section 3.4) and how such changes helped to enhancing livelihood capitals (natural, physical, human, financial and social), thereby providing a basis and conducive environment for the individual household's livelihood strategy and outcomes.

The first, and probably the most important cause and underlying mechanism for the impact on livelihoods is the enhancement of Rupa watershed 'natural capital', through transformation of the entire watershed landscape and restoration of the agriculture, forest and wetland ecosystems. This has been possible through rehabilitation of the denuded hill slopes by planting trees and protecting degraded forests, regeneration of water sources (natural streams, ponds and lake), and revival of the previously disappeared local crop varieties. Improvement in ecosystem services has been reported by both participant and non-participant households. According to the JSA and RLRFC leaders, the availability of forest products has increased greatly. Similarly, with enhanced water recharging capacity of the watershed, there is now increased amount of water for household use and farmland irrigation. The reduction of top soil erosion and landslides has reduced downstream sedimentation and siltation. The productivity of both farmland and Rupa Lake is reported to have increased substantially. Farmers are now increasingly growing the revived local crop varieties and producing fish in the lake for both household consumption and supply to markets. In 2018 alone, income from the sale of fish products was worth around NPR 17 million (USD 154,166). All of these highlights the fact that investments in sustainable management of common property resources contribute to enhance natural capital which could then be utilized by individual households for their livelihood strategy and outcomes.

Another important cause and underlying mechanism for the impact on livelihoods relates to the enhancement of 'physical capital'. The recent decades have witnessed rapid development of basic infrastructure/facilities such as motor roads and communication networks, schools and branch offices of various government departments, as well as formal and informal financial institutions and cooperatives in the Rupa watershed area. These developments, particularly the transport and communications sector, have contributed to increasingly integrate Rupa watershed area into the broader market economy, with access to off-farm income and other means of diversifying livelihood options. The physical capital of the Rupa watershed area was further strengthened by JSA and RLRFC by constructing their own centers and facilities. One of the reasons for these social organizations to invest in such physical structures is that not only do they provide space for office, meetings and training/workshops, but also serve symbolic identity and value of the organizations in the community and general public. Enhancing physical capital at community level have demonstrated that they contribute to stimulating local economy (eco-tourism, market expansion of local agricultural products, proliferation of hospitality business, generation of local employment, etc.), which might partly explain that participant households' assets have higher economic values compared to non-participant households.

Building and strengthening 'human capital' on the sustainable utilization and management of Rupa watershed's natural resources has been the major objective of all the six projects implemented to build resilience, and included significant capacity building component and investment. In addition to the technical knowledge and skills relating to

forest/tree regeneration, soil and landslide control, wetland protection, and conservation of local crop varieties and their genetic resources, the local people, especially the RLRFC and JSA leaders, were able to strengthen their social, communication and management skills and capacities (e.g., knowledge and skills related to the mobilization of local human resources for local development work, the management of their respective organizations in ways that are participatory, transparent and accountable, and building internal and external relationships with a range of stakeholders). Today, according to the JSA and RLRFC leaders, the Rupa watershed community has many local individuals with social, technical and organizational management capacities required for sustainable management and utilization of Rupa watershed ecosystems.

Building 'financial capital' is yet another important cause/underlying mechanism for the impact on livelihoods in Rupa watershed area. The Rupa watershed community has many formal and informal financing institutions. RLRFC, JSA and mothers/women's groups run their own savings and credit schemes. As a result, individual households now have ready access to collateral free low interest loans. The extent to which the community level financial capital has been built over time in the Rupa watershed area is reflected from the action of RLRF and JSA. Under the leadership of RLRFC, the RLRFC runs a separate Savings and Credit wing that provides collateral free low interest loans to its members. Likewise, four years ago, JSA created a Community-based Biodiversity Management (CBM) Fund to support its 17 member groups and through them to enhance livelihoods of their members. Due to the rapid proliferation of, and ready access to, financial institutions and because of the increasing numbers of Rupa watershed inhabitants using and benefiting from them, there is no difference in access to credit between participant and non-participant households. However, there is nevertheless difference in the utilization of loan money where participant households tend to invest in trade and business that generates income and support capital accumulation at household level, while non-participant household tend to invest more on agribusinesses, which normally are more risky undertakings.

The last, but not the least, important cause and underlying mechanism for the impact on livelihoods is the way in which the Rupa watershed's 'social capital' was build and strengthened. As indicated in Section 2.3.5, the approach and policy adopted by all six projects implemented to build resilience was to work with existing local organizations (as was the case with RLRFC and mothers/women's groups) or by forming new organizations/groups such as JSA and CFUGs. Not only did such approach and policy assisted in the mobilization of local human and institutional resources in field implementation of project activities, but it also helped to create a sense of ownership of the projects among the local people and organizations. It is because of the presence of such strong (or strengthened) social capital in the form of credible local/community organizations such as RLRFC and JSA that community level actions and responses were possible to regenerate the Rupa watershed's natural resources and transform the entire landscape. Augmentation of social capital for participant households is significantly higher than for non-participant households (Section 5.1.5) because these projects have invested considerable time and resources building capacity of leadership in these organizations to establish and strengthen relationship and networks with relevant government and other institutions. Hence, better social networks in government offices, academic institutions, healthcare and business organizations were reported by participant households as against non-participant households, and these connections and networks facilitated and reinforced enhancement of other livelihood capitals.

Inter-linkages and Influence of Livelihood Capitals on Livelihood Strategy and Outcomes

For understanding the way individual household used the above livelihood capitals for their livelihood strategy and outcomes, we analyzed household

survey findings using multiple regression analysis. The analysis indicated that out of several factors, six factors namely household's participation in development projects, high risk taking behaviour, land ownership, number of migrant workers from household, access to loan from banking system, and household assets (house, plots of land) positively influence income of the household. The regression analysis result clearly indicates that participant households have higher income than non-participant households. Individual traits such as risk taking is associated with innovativeness, starting new businesses, migration etc., which ultimately leads to diversification of livelihood options resulting in higher household income. Livelihood capitals (land ownership and household assets) have positive relationship with income. Inflow of remittance money from migrant workers have positive impact on household income, so number of migrant workers positively influence household's livelihood. Finally, the sixth factor to have positive impact on household income is access to financial services.

Analysis of factors influencing household energy use for cooking reveal that seven factors played statistically significant positive role in the process. Among these seven factors, participation in projects have the most profound impact on household's choice of energy use. Other important determining factors include family size, number of employed in household, and social network with government/ municipalities. It's interesting to note that higher social capitals (network with government officials, health care experts and membership in community forest user group) positively influence cleaner form of energy use for cooking.

The diversity and frequency of food intake of sampled households is influenced by six different factors, with two factors (age and caste of respondent) having inverse relationship with food intake. Among these factors, total land ownership has the most influence on diversity and frequency of food intake. High risk taking behaviour influenced the diversity and frequency of food intake, and so did the participation of households in projects. It's striking to note that two factors such as age and caste have negative impact on food intake, which indicate the older age group and *Dalits*[2] consume less diverse/frequent foods. Comparative analysis of factors influencing different livelihood outcomes viz. income, clean energy use for cooking, and diversity/frequency of food intake revealed that different set of factors contributed to different livelihood outcomes, with participation in projects and individual risk taking behaviour contributing positively to all tested livelihood outcomes.

In general, three key messages emerge from the above analyses. Firstly, ready access to (or availability of) livelihood capitals/assets is critical for sustainable rural livelihoods. Secondly, the livelihood capitals, especially the common property resources (forests, water sources, etc), social and financial institutions (e.g., the presence of local organizations such as JSA, RLRFC, cooperatives, mothers/ women's groups) physical infrastructure (motor roads, communication networks), and human capabilities (knowledge/skills and leaderships) constitute an integral parts of strengthening rural livelihoods, and therefore, sustainable management, utilization and enhancement of these resources is critical. The third and final message is that an ideal strategy for sustainable rural livelihood outcomes would be one which involves investment of resources in strengthening livelihood capitals/capabilities at both community and household levels, instead of focusing and investing resources on one level and undermining the other.

While the analysis shows an overall positive impact on the livelihoods of Rupa watershed inhabitants, one needs to be mindful of the potential challenges/issues which could undermine the above achievements. For example, as have been explained in Section 3.4.10, it is possible for project interventions to give rise to unintended (undesirable) results, such as the human-wildlife conflicts that have arisen as a result of the rehabilitation of the Rupa watershed. There is also possibility for a new unexpected developments, such as the COVID-19 pandemic, to emerge and exert myriads of pressures on the resilience of ecosystem and local livelihoods.

[2] Occupational caste/ethnic groups who are socially, economically and politically discriminated or marginalized in historical terms.

Therefore, it is important for CEL nexus programme to be able to foresee/speculate such challenges that could potentially present implications on ecosystems and livelihood policy actions.

Potential for Replication/ Up-Scaling

The study shows that initiatives implemented to build resilience in the Rupa watershed of Nepal has had overall positive impacts on the livelihoods of Rupa watershed inhabitants. It should be noted that these initiatives were not designed and implemented with CEL programming concept in mind, but had elements of CEL programme. The study shows that there is potential for up-scaling Rupa watershed experience both within Nepal and beyond.

The key lessons learned from this study is that for successful replication of Rupa watershed experience, it is important to consider the following factors: (i) selected area/site is not too large, rather should be within the technical know-how and managerial reach of the local communities; (ii) the local communities share a common interest, as in the case of Rupa watershed (i.e. ecosystem restoration and conservation for resilient livelihoods), as opposed to varied or conflicting interests, which often tends to be case when the intervention area is too large; and (iii) the watershed resources and services it provides are critical for sustaining local livelihoods and are in a deteriorating conditions.

In the context of Nepal, preliminary assessment shows that there are a number of potential areas/ sites where Rupa watershed model could be further strengthened by integrating CEL programming concept for testing and refining through the design and implementation of pilot project. The sites located in high hills/mountain region or within the protected areas are not recommended because these sites are sparsely populated and there is little or no human interaction within the site. These sites are more of 'Sites for Special Scientific Interest'. There are a number of potential sites in the mid-hills and lowland Terai regions, with potential for replication. These sites are in deteriorating conditions, but are important for sustaining local livelihoods. Five lakes in Lake Cluster of Pokhara Valley and Indra Sarovar Lake in Makwanpur district in the mid-hills, and Jagadishpur Lake in Kapilvastu and Ghodaghodi Lake in Kailali districts are promising sites. One site each in the mid-hills and lowland Terai could be further prioritized for the design and implementation of pilot project. The key learning generated by the pilot project could then be replicated across other promising sites and regions through policy discourse. There is also potential for up-scaling Rupa watershed experience in China, especially in provinces that share similar socio-economic and environmental conditions. The implementation of pilot project in Nepal and China will allow exchange of knowledge and experience between two communities and countries to learn from each other. Such an approach is likely to have far reaching impact. For example, the lessons generated by pilot project in Nepal and China could be used as 'Learning and Influencing' tool at the global stage through participation and exchanging information in international events such as UN Climate Summit.

Rupa Lake in the foot-hills with stunning views of villages in the hill slopes and Himalaya range on the background.

1. INTRODUCTION

At the end of 2016, the United Nations Environment Programme (UNEP) launched, a decade long (2016-2025) flag-ship programme on Climate Change, Ecosystem and Livelihood (CEL), with the aim to assist the developing countries in delivering the SDGs and climate targets while protecting ecosystems and improving rural livelihoods. The CEL programme is a major initiative supported by China and other developing countries to promote long-term South-South Cooperation, led by UNEP-International Ecosystem Management Partnership (UNEP-IEMP). Regions and countries for implementing the CEL programme are to be identified according to their types of fragile or degraded ecosystems, significance of biodiversity hot spots, vulnerability to climate change impacts, poverty level, population pressures and livelihood needs. The programme focuses on dryland, mountains, river basins and coastal areas (Zhang et al., 2018).

For testing CEL programme in Asia, the Institute of Geographic Sciences and Natural Resources Research (IGSNRR) under the Chinese Academy of Sciences (IGSNRR-CAS), with support from UNEP-IEMP, developed a project entitled 'Sustainable Livelihood and Green Development Strategies in Environment-Economic Fragile Areas: Identifying and Assessing a Demonstration Site on Sustainable Livelihood in Rural Areas'. The project aimed at identifying sites where there have been some project interventions and where their positive impacts on the livelihoods and ecosystems could be used for demonstration and scaling up more widely. Nepal is one of the countries/sites selected for the case studies. The other countries/sites include Southeast Asia and Southwest China (Figure 1).

In order to explore the demands and opportunities for the promotion of CEL programme in Nepal, with support from LI-BIRD, the UNEP-IEMP/IGSNRR-CAS team, selected Rupa Lake watershed area, located in Kaski district of Gandaki province for the case study (Figure 2). LI-BIRD has been responsible for the implementation of the case study in Nepal with guidance from UNEP-IEMP/IGSNNR-CAS. The study was spread over the period December 2019 –June 2020.

This report is structured into seven sections. The introduction (Section 1) is followed by the background information and climatic and ecological vulnerabilities of Nepal in general and the study site in particular, including a brief information about CEL programme (Section 2). Section 3 describes the Rupa watershed area and provides information about various projects/initiatives implemented in

Figure 1: Map showing the location of the case study countries/sites

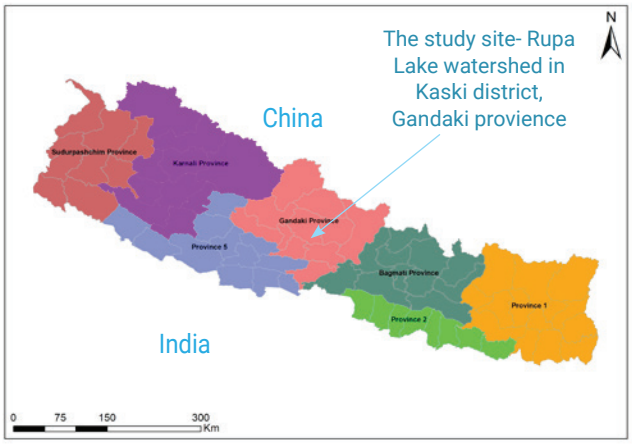

Figure 2: Map of Nepal showing the study site

the study site to build resilience and changes that have occurred over the years, and explains why this site is appropriate for assessing CEL programme demonstration on sustainable livelihoods, thereby setting a context for the case study. The methodology and approaches used for the case study is presented in Section 4. Section 5 present the key findings, which is followed by the analysis of causes and underlying mechanisms for the impacts on livelihoods (Section 6). The potential for replication/up-scaling Rupa Lake watershed experience and approaches within Nepal and possibly beyond, including a pilot project to further test and refine the Rupa watershed model, and for the development of pathways for up-scaling in future is presented in Section 7.

2. BACKGROUND INFORMATION AND CLIMATIC AND ECOLOGICAL VULNERABILITIES

2.1 The Sustainable Development Goals, Climate Change and Ecosystem Management

In 2015, two global agendas were endorsed by world leaders. One was the 2030 global agenda with 17 ambitious SDGs, which include sustainable management of ecosystems, halting biodiversity loss, ending poverty and hunger, and combating climate change (UN, 2015). The other was the Paris Climate Change Agreement which emphasizes the need to strengthen climate actions in the efforts to sustainable development and eradicating poverty. The SDGs and Paris Agreement are closely interrelated and complementary agendas to one another, and hence achieving their targets requires an integrated effort by concerned actors.

Ecosystems are the natural foundation of economic activity, human well-being and the functioning of the earth system. Many people in the developing countries, especially the poor, depend for livelihoods on what has now become degraded ecosystems (Box 1). Ecosystem-based approach is increasingly being seen as a promising way to link climate change and disaster risk reduction with sustainable livelihoods and development (Munang et al., 2013; quoted in Zhang et al., 2018).

Box 1: Ecosystem and ecosystem services and management

Ecosystem: A community of living organisms in conjunction with the non-living components of their environment – air, water, soil, mineral, sun etc – interacting with each other as a system/functional unit.

Ecosystem Services: The benefits people obtain from the ecosystems: provisioning services (e.g. food, water), regulating services (e.g. regulation of floods, drought, land degradation, diseases), supporting services (e.g. soil formation, nutrient cycling), and cultural services (e.g. spiritual, recreational, religious & other non-material benefits)

Ecosystem Management: An integrated process to conserve and improve ecosystem health that sustains ecosystem services for human well-being.

2.1.1 The CEL Programme - Conceptual Framework and Thematic Priorities

In 2016, UNEP launched a decade long (2016-2025) flag-ship programme on CEL, with the aim to assist the developing countries in delivering the SDGs and climate targets while protecting their ecosystems and improving livelihoods of their people. The programme is a major initiative supported by China and other developing countries to promote long-term South-South Cooperation (SSC), led by UNEP-IEMP/IGSNRR-CAS. The CEL framework (Figure 3) is based on two fundamental premises: (i) the relationships among climate change, ecosystems and livelihoods are multifaceted, interdependent and interactive (Chhatrar and Agrawal, 2009; Lewis et al., 2015; Peel et al., 2016; quoted in Zhang et al., 2018), and (ii) solutions to the spiral of climate change impact, ecosystem degradation and the on-going poverty depends upon how best one can treat these issues (Romero and Agrawal, 2011; Nilsson et al., 2014; quoted in Zhang et al., 2018). Hence, primary priority of the work is the nexus of climate change, ecosystem services and livelihoods – i.e. synergy of ecosystem services and sustainable livelihoods in a changing climate. Secondary priority involves paired interactions between climate change and ecosystem services, climate change and sustainable livelihoods, and ecosystem services and sustainable livelihoods. The programme is expected to encourage cross-sectoral cooperation and enhance interdisciplinary research that brings together natural science, economics and social science (Zhang et al., 2018). The UNEP-IEMP/IGSNRR-CAS led CEL programme seems to be appropriate to help address many of Nepal's poverty and environmental problems and to assist in achieving its commitment for the SDGs and climate targets.

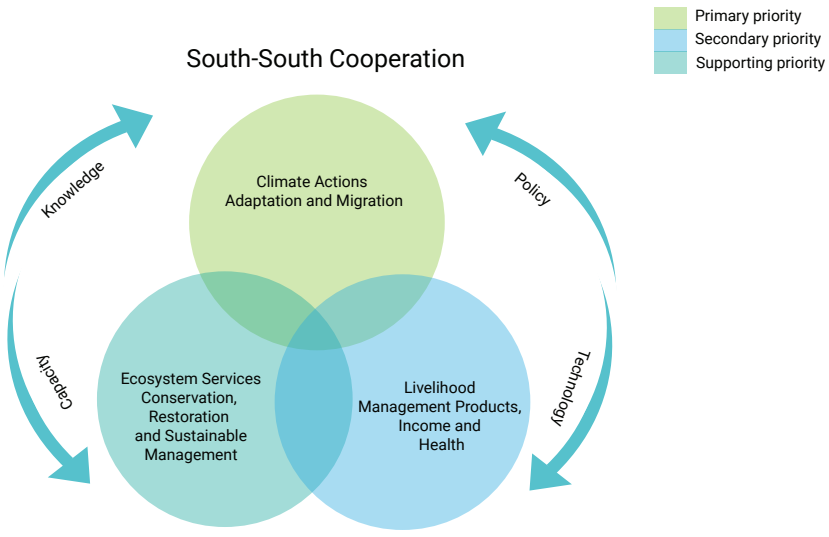

Figure 3: CEL conceptual framework (quoted by Zhang et al., 2018)

2.2 Background Information of Nepal

With more than 28 million population and per capita income of US$1,047 (GoN, 2019), Nepal is challenged by such problems as environmental degradation, poverty, unemployment, rural depopulation, unplanned urbanization, poor infrastructure, low financial capacity, growing trade imbalance and many other problems that arise from these. Of the 77 districts, 14 districts are listed as highly climate vulnerable and over 50 districts as food insecure (Ministry of Environment, 2010). Increasing numbers of rural young men and women are reported to migrate every year to cities and abroad in search of jobs. In 2019, some 5 million Nepalese were reported to be employed overseas. Once a net food exporting nation in the 1970s, Nepal currently is a net food importing country. These challenges are most likely to jeopardize Nepal's sustainable development effort, especially the poverty alleviation and food security goals. Nevertheless, Nepal is blessed with rich natural, biodiversity and cultural resources. There are abundant renewable natural resources, especially river water, with huge potential for generating hydro-electricity. With more than 44% of the land covered with forest and extensive fertile agriculture land in mountain valleys and lowland Terai plains, there is huge scope of agriculture and forest based industries. Located in the foot-hills of Himalaya with beautiful landscapes and fascinating culture, tourism is Nepal's second highest contributor to the nation's income after the agriculture sector and the second highest foreign currency earning sector, after the remittance. If these resources are sustainably managed and utilized, Nepal's poverty level can be reduced many times faster than the present rate.

In view of this, the Government of Nepal (GoN 2019) has introduced programme of 'Prosperous Nepal, Happy Nepali' that includes the long-term 'prosperity' target (accessible modern infrastructure and intensive connectivity, high and sustainable production and productivity, high and equitable national income, etc), and the long-term 'happiness' targets (well-being and descent life, civilized and just society, healthy and balance environment, national unity, security and dignity, etc). The Government aims at lifting the nation's status from a least developed country to a developing country by 2023. Nepal is a signatory country of the Sustainable Development Agenda 2030 and the Paris Agreement on Climate Change, with commitment to support in attainment of the SDGs and the UNFCCC climate targets. The government recognizes the need to achieve these targets while protecting and preserving the nation's environment and ecosystems. Therefore, this case study is seen as a unique opportunity to explore/test the CEL nexus approach and to provide a perspective on how to up-scale as a promising pathway to sustainable development in Nepal.

2.3 Background Information of the Study Site

2.3.1 Location of Rupa Watershed Area, Population, Physical Infrastructure and Facilities

Located in Kaski district of Gandaki Province, 200 kilometre west of Kathmandu, the Rupa watershed area encompasses Ward No. 31 of the Pokhara Metropolitan City, Ward No. 6 & 7 of the Rupakot Rural Municipality, and Ward 4 of Madi Rural Municipality, covering a total area of 2,707 ha of land, with altitudes ranging between 580 to 1,420 MASL (Figure 4.1 and 4.2).

The Rupa watershed area is fairly accessible, with roughly an hour drive from Pokhara City and half an hour from the Kathmandu-Pokhara motor highway (K-P highway). Two motorable pitched roads link the watershed area to the K-P highway, and there is pitched road to Sundaridanda, Talbeshi and the Lake side – with regular public bus service to these places to and from the K-P highway. In addition, several fair weather roads link most of the settlements within the watershed. There are many other basic facilities and services, including health centres, schools, colleges, internets and a range of government offices (e.g. drinking water, electricity, agriculture and livestock service centres, etc) as well as banks and financial institutions.

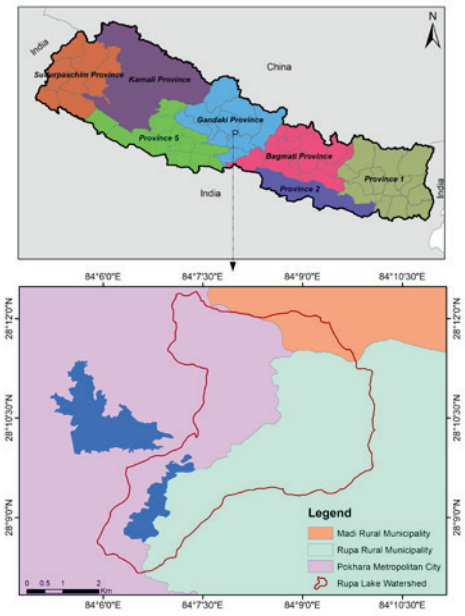

Figure 4.1.: Location map of Rupa watershed area

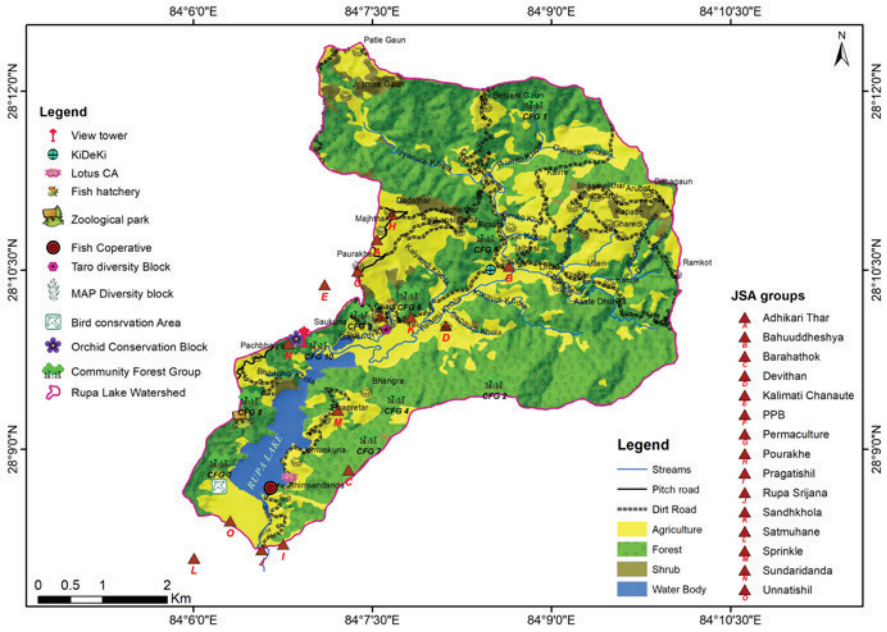

Figure 4.2.: Social and resource sketch map of Rupa watershed area

The image processing was performed using the ArcGIS software (Version ArcGIS 10.5). Atmospheric correction was performed using metadata provided with the scene using raster calculator tool. Based on high resolution imagery from Google Earth and base map as a reference data, five LULC categories were identified: (i) forest land (ii) agriculture land: (iii) barren land: (iv) settlements: and (v) water bodies. The training samples data were generated from the visual interpretation of false colour composition of different spectral bands. To evaluate the class separability of the training areas, band-specific scatter plot was created to determine if there is any overlap between the classes. Maximum likelihood classifier was used for the classification of the Landsat images based on the signature file created from the training samples. The land use area was calculated based on number of pixels per class cover. For the year of 1992/93, the GoN Survey Department land use map were used.

Among the Rupa watershed's special features include its beautiful landscape with Rupa Lake at the low lying basin/valley and several settlements/ villages in the hill slopes and ridges, such as Sundaridanda, from where one can have an overview of the Rupa Lake and at the same time stunning panoramic view of the Himalayan mountain range. The Rupa Lake is also a part of the Lake Cluster of Pokhara Valley (LCPV), involving nine Lakes. Rupa is the third largest Lake, after Fewa and Begnas[3]. In February 2016, the LCPV was registered as Nepal's 10th Ramsar site which at present remains the only Ramsar site in the middle hill region of Nepal.

[3] The other six Lakes of the LCPV are Dipang, Maidi, Khaste, Neurani, Kamalpokhari and Gunde.

Some 1,185 households (5,332 people) are reported to be registered as residents of Rupa watershed area, of which, 51.4% are female and the rest are male. 57% of the total population fall in the Brahmin, Chhetri, Thakuri and Newar ethnic category, 26.2% in the Janajati group (Gurung, Magar and others) and 16.6% the *Dalits*. Some 67% of the population fall in the age group of 15 to 60 years. The average literacy rate is estimated at 75.6% (male 83.5% and female 67.7%) - a figure higher than the national average, which is estimated at 67.3% (GoN, 2018).

For living, the Rupa watershed inhabitants draw income both from on-farm and off-farm employment. They produce farm produces for household consumption and to sell in the local market. Appreciable number of people hold regular jobs in the government and non-governmental organizations, while others are engaged in seasonal

jobs in Pokhara City, other nearby urban places and overseas employment as migrant workers. Some household members have started own businesses such as agri-business, grocery shops, hotels, restaurants, transport, tourism etc. It is hard to find a household that does not have access to off-farm income. Some households have multiple sources of off-farm income, earning much greater cash income than that they earn from their farmland.

2.3.2 Topography, Climate and Vegetation

The Rupa watershed area has steep north and south facing slopes of 35-60 degree, with altitude varying from 580 -1,420 MASL. The climate is sub-tropical and humid, and is marked by monsoon rainfall. The pre-monsoon period is generally hot and dry, and hailstorms is common during pre-monsoon season. The average total precipitation over the period of 25 years (1985-2010) is 3,474 mm with an average of 128 rainy days (DHM/Nepal, 2012). Over a period of 30 years (1981-2011), the maximum and minimum average temperatures have increased by 0.810C and 0.20C respectively (Dixit et al, 2014).

Vegetation and crop cultivation are largely determined by climate and topography, with people using the south-east facing slope and lowland for crop cultivation. Forests are predominantly sub-tropical and wet, although some patches of temperate forests exist at higher altitudes. The predominant species of sub-tropical wet forests include Katus (*Castenopsis indica*), Chilauni (*Schema wallichii*) and other species include Kafal (*Myrica esculenta*) and Utis (*Alnus nepalensis*). Temperate forest species include Phalat (*Quercus glauca*), Paiyu (Prunus ceresoides) and Gurans - various Rhododendron species (K.C et al., 1987 quoted in Bogati, 1996).

2.3.3 Land and Related Natural Resource Use

Of the total area of 2,707 ha, 33.57% is agricultural land and 0.89% is barren land. Some 61.85% and 3.69% of the areas are covered by forests and water bodies respectively. There are three types of agriculture land; Bari (the rain-fed area where mostly dry crops such as maize and millet are grown), Khet (the irrigated area where generally rice and wheat are grown) and Kharbari or Pakho (the marginal lands where fodder grass and trees are grown). In general, the Bari terraces are located on the upland slope where there is limited or no irrigation facility whereas the Khet are found in the lowland flat areas where there is often irrigation facility.

Almost all of the forests in the watershed area are now managed by local communities as community forests. 14 Community Forest User Groups (CFUGs), involving 2,785 households are reported to be managing the community forests. In addition to Rupa Lake, there are many natural streams and ponds. Among the principal streams are Dovan Khola, Chisa Khola, Sanophedi Khola and Dholphedi khola, which feed water into the Rupa Lake and also serve as source of drinking water for local communities and water for irrigating agriculture land, especially in lowland area.

2.3.4 Ecosystems in the Rupa Watershed Area

Recently, the term ecosystem(s) is increasingly being used in the development and environment fields. According to the types of ecosystems and definitions used in the literature, the Rupa watershed landscape has three distinct ecosystems. These are agriculture or agro-ecosystem, forest ecosystem and wetland ecosystem (Box 2). While these ecosystems have their own specific characteristics, their benefits to humans (provisioning, regulating and cultural services) are similar.

In Rupa watershed area, these ecosystems have gone through periods of deterioration due to over use and lack of appropriate management regime. Among the three ecosystems, the forest ecosystem, at present, seems to be fairly stable because of the reduced pressure and the introduction of community forestry mechanism for forest management, but the agriculture and wetland ecosystem are still going through many changes. These two ecosystems are also relatively more vulnerable to the impact of climate change and natural hazards than the forest ecosystem.

Box 2: Ecosystems in the Rupa watershed area

Agriculture/Agro-Ecosystem: A system managed with a purpose, usually to produce crop and/or animal products - designed by human and are based on a long term chain of experience and experiments. The emphasis has changed from maximising productivity to also include environmental consideration (Andren & Kutterer, 2008).

Forest Ecosystem: A dynamic complex of plant, animal and microorganism communities and their abiotic environment interacting as a functional unit, where trees are a key component of the system. Humans, with their cultural, economic and environmental needs, are an integral part of managing forest ecosystem (CBD, 2001).

Wetland Ecosystem: A dynamic complex of plant, animal and microorganism communities and their abiotic environment in a given wetland area interacting as a functional unit. Wetland involves area of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres (MEA, 2005).

2.3.5 Local Organizations and Networks

Aside from public service centres, such as public schools, health centres, there exist several local social, environment and community development groups/ organizations (Table 1). Some of these groups were formed by local people on their own initiative (e.g. Mother's Groups, Community Development Committee, Rupa Lake Restoration and Fishery Cooperative (RLRFC) while others were formed with support from sponsored projects (e.g. Jaibiksrot Samrakchan Abhiyan/JSA, and community forest user groups). These organizations, are formally registered in respective government offices in Pokhara, are associated with, and managing at least one of the above three ecosystems.

Among various local organizations, JSA and RLRFC are the two most important community-based organizations active in Rupa watershed area. Therefore, this study focused exclusively on

Table 1: Types and numbers of local organizations in the Rupa watershed area

Type of organization	No.	No. of households as members	Remarks
JSA (Community organization)	1	1,297	Umbrella organization with 17 local groups, 2 cooperatives, 1 community development committee & 1 NGO as members
RLRFC and Pratigya (Cooperative)	2	854	Both RLRFC and Pratigya cooperatives are members of JSA as an organization, but member households of RLRFC and Pratigya are not member household of JSA
Mothers/women's group	9	295	Some of these groups are associated with JSA while other are associated with RLRFC
Community development committee	1	67	JSA member
Community forest user group	14	2,785	
Environment/nature conservation group	3	142+	3 mothers/women's groups each involved in wetland management, conservation of white lotus, and environmental conservation – all are members of RLRFC
Farmer's group	5	120	
Rupa saving & credit scheme	1	854	Formed on the initiative of the RLRFC members

households who were members of JSA and RLRFC and who participated and benefited in some ways from the project interventions. A brief account of JSA and RLRFC is presented below:

Jaibiksrot Samrakchan Abhiyan (JSA) - JSA was established in 2006 with the objectives to: (i) operate as an umbrella organization and support the groups to continue (after the termination of LI-BIRD/UNDP supported Community Biodiversity Register/CBR project) their work of conserving and promoting local crop varieties; (ii) enhance group members' livelihoods by supporting income generating activities; and (iii) raise and manage funds and establish linkage to seek support from various government & non-governmental organizations. The main reason was the termination of the then CBR project and concerns of the groups, and therefore, the need felt by the groups to continue and sustain what they were doing in conserving and utilizing local crop genetic resources of the Rupa Lake agroecosystem. Since then JSA is operating as an umbrella organization with 17 farmer groups, 1 community development committee, 1 NGO and 2 cooperatives as JSA's members.

As of December 2019, there were a total of 1,297 households as members of JSA. The Executive Committee meet on a monthly basis, and JSA also organizes general assembly meeting once a year where the executive committee presents the annual progress report, including details of income and expenditure, challenges faced, way forward etc to its members. The JSA seems to have operated as an umbrella organization and supported its groups reasonably well. It has continued to support the work of conserving and promoting local crop and vegetable varieties and local bee farming (honey production). It has managed to secure funding and technical support to establish a Biodiversity Information Centre in Sundaridanda. Not only does the centre provide information on local biodiversity, but it also generates income from visitors, and is contributing towards the promotion of eco-tourism in the Rupa watershed area. It has also secured fund to use as seed money to set up a Community-based Biodiversity Management Fund (CBM fund) which is used as 'Revolving Fund' to enhance its group members' livelihood. The fund has now increased from NPR 635,000 to over NPR 1.4 million. Some group members reported to have earn as much as NPR 150,000 annually from the initial loan of NPR 5,000 from the revolving fund. One of the main reasons for the JSA to operate successfully is the willingness of groups - which previously were working separately - to come together and form an umbrella organization. The other reason is revolving fund – as a major factor to keep together those groups that are still tied up with the JSA.

Rupa Lake Restoration and Fishery Cooperative (RLRFC) – RFRFC was established in 2002 with three objectives: (i) rehabilitation and restoration of the Rupa Lake; (ii) enhancing income/livelihoods of the cooperative members/shareholders; and (iii) conservation of local wetland biodiversity. The main reason for the initiative was rapidly declining condition of the Rupa Lake due to increased sedimentation and siltation, increased infestation of weeds and invasive species in the Lake, and rapidly declining fish production, thereby affecting the livelihoods of local/traditional fishing community members who depended on Lake fish for living.

As of December 2019, there were a total of 854 households as RLRFC members. The Executive Committee meets on a monthly basis and organizes general assembly meeting once a year where all the household members attend and where the Executive Committee presents the annual progress report, including details of income and expenditure, challenges faced, way forward etc. The RLRFC's progress and achievement appears to be quite remarkable. For example, they have been successful in restoring the Lake (to a large extent). Annual production & sale of lake fish now is worth NPR 25 million. The membership of the cooperative has reached 854 from 38 in the starting year and the share price has increased from NPR 5,000 to 40,000/ share. Five years ago, the cooperative members decided to set up a Savings & Credit Scheme to increase easy access to credit for its members. The cooperative now employs 24 full-time staff and several part-time staff. With the help of CBR and Community-based Wetland Management (CWM) projects, the cooperative has now documented

local fish, bird and plant biodiversity of Rupa Lake and the surrounding wetland areas, and some of them are displayed in the Biodiversity Information Centre in Sundaridanda. It received a national award from the Ministry of Agriculture and Livestock Development for outstanding work in restoring Rupa Lake and enhancing livelihood of local people through sustainable utilization of fish produced in the Lake. More recently, the cooperative leadership has been able to lobby with the Federal Government to construct Rupa dam with the investment of approximately NPR 4.52 billion. There are a numbers of actions/decisions by the RLRFC leadership at different times which played major role in the effective functioning of the organizations. These include, but are not limited to: (i) decision to form Rupa cooperative; (ii) action to clean the Lake and construct fish enclosures and protect the water source in the up-stream; (iii) action to include the traditional fishermen and local labourers as shareholders; (iv) decision to buy 7 ropani (0.35 ha) land to set up its own fish hatchery centre and conserve local fish species; (v) sharing part of the profit to invest on upstream areas through the mechanism of grants (payment for watershed services) to CFUGs, women groups, scholarships to schools and supporting local club's activities; (vi) action to set up a Savings and Credit Scheme; and (vii) decision to lobby with the federal government to construct a dam in Rupa Lake.

This section describes how the Rupa watershed area managed to recover from a very depressing social, economic and environmental situation to an area where the functioning of the watershed's three ecosystems is much improved and enhanced and are now delivering their goods and services to the watershed inhabitants and generally. These ecosystems and the people depending on them for livelihoods are also in a relatively better position to adapt to the impact of climate and other changes.

3. THE PROJECT/ INITIATIVE IMPLEMENTED TO BUILD RESILIENCE

3.1 Project Interventions

In the past two decades, six projects relevant to CEL programme were implemented in the Rupa watershed area. Basic information on these projects (e.g., project title, duration, objective, funding agencies etc) is summarised in Table 2. The large majority of these projects were implemented through two local organizations i.e. JSA and RLRFC (see 2.3.5 above). In this case study, RLRFC and JSA are regarded as two initiatives crosscutting the projects mentioned in Table 2 below.

LI-BIRD started working with Rupa watershed communities in 1996. Starting with Strengthening the Scientific Basis of In-situ Conservation of Agricultural Biodiversity On-farm Project (In-Situ project), LI-BIRD in the subsequent years became involved in a number of small sized community based projects, including Community Biodiversity Register (CBR) and Community-based Wetland Management (CWM) projects. Prior to LI-BIRD's In-Situ project, CARE Nepal supported Begnas Tal Rupa Tal (BTRT) Watershed Management Project had been operating for over a decade (Bogati, 1996).

This case study originally intended to assess the impact of five years or less old projects, but the study team felt that the BTRT and In-Situ projects should be included for the review, as they played major role in addressing the environmental and biodiversity problems facing the Rupa watershed. The other projects, which were subsequently implemented in the Rupa watershed area, were built on the foundation established by these two projects.

Table 2: Project/initiative implemented to build resilience in the Rupa watershed area

Project, duration, funding agency/ Collaborator(s)	Project objective/s	Beneficiaries
1) Begnas Tal Rupa Tal Watershed Management Project (1985-1998) funded by DGIS Netherlands and GoN, and implemented by CARE Nepal	To contribute to environment protection and poverty alleviation through rehabilitation and management of the Begnas and Rupa watershed resources	Begnas and Rupa Lake watershed residents
2) Strengthening the Scientific Basis of In-situ Conservation of Agricultural Biodiversity On-farm Project (1997-2001) funded by NEDA Netherlands, IDRC Canada and Bioversity International, and jointly implemented by LI-BIRD and Nepal Agriculture Research Council	• To support the development of a framework of knowledge on farmer's decision making process that influences in-situ conservation of agricultural biodiversity • To strengthen national institutions for the planning and implementation of conservation programmes for agricultural biodiversity, and • To broaden the use of agricultural biodiversity and the participation in its conservation by farming communities and other groups	22 groups comprising 759 households
3) Community Biodiversity Register Project (2003-2005) funded by UNDP/ GEF-SGP, and implemented by LI-BIRD	Strengthening local capacity in managing community biodiversity for documentation and utilization of biodiversity	17 groups comprising 854 households, 2 cooperatives, and 6 women groups
4) Community-based Wetland Management Project (2006-2007) funded by IUCN and implemented by LI-BIRD	Community based integrated management of wetland and watershed areas for conservation of wetland biodiversity and enhancing livelihoods of wetland communities in Begnas and Rupa watershed areas	RLRFC comprising 854 members, women groups, the ***Dalits*** & indigenous people/fishers
5) Enhancing Benefits to Smallholder Farmers by Linking Agrobiodiversity to Niche Market Project (2007-2011) funded by The Development Fund Norway, and implemented by LI-BIRD	• To increase productivity of biodiversity based production systems of poor farmers for improved livelihoods & their resilience to climate change • To strengthen capacity of farming communities to conserve, utilize & benefit from agriculture biodiversity	Pratigya Cooperative and 150 smallholder/land poor households
6) Mobilizing Local Resources and Institutions for Integrated Management and Utilization of Watershed Services in the Mid-Hills of Nepal (2014-2017) funded by Swiss ReSource Foundation, and implemented by LI-BIRD	To strengthen and scale up 'Payment for Watershed Services' mechanism for sustainable management of biodiversity and natural resources for improving livelihoods of Begnas and Rupa watershed residents	1,000 households of the Begnas and Rupa watershed area, community organizations, cooperatives, and community forest user groups

3.2 Situation of Rupa Watershed Prior to the Project Intervention (Mid-1980s)

The Rupa watershed inhabitants had, for generations, depended for living on integrated farming systems in which farmland, forest, livestock, and water resources were intertwined. They depended heavily on public forestlands that supplied firewood and timber for household use, and fodder for farm animals. They also used the forestland for grazing animals. Firewood then was the only source of energy for cooking and heating. By mid 1980s, when the BTRT Project began to operate, most of the forest in the Rupa watershed area had been completely deforested due to over harvesting of trees for fodder, firewood and timber for household needs, overgrazing, and setting forest fires in the pre-monsoon months so that grass could regenerate in the rainy season for grazing animals. The loss of forest cover accelerated the process of soil erosion on the hill slopes, frequency of land slides and flooding, thereby increased sedimentation down-stream during the monsoon while, in the dry season, causing for drying up of natural streams – the main source of drinking water for local communities and that fed water into Rupa Lake. The loss of top soil due to erosion of the hill slopes led to rapid decline in the productivity of the farmland. The Rupa Lake was increasingly being filled with sediments and aquatic weeds, such as water hyacinth and water chestnut, affecting the production of lake fish, thereby the livelihoods of indigenous fisher communities who depended on Rupa Lake fish for living. Awareness and importance on conservation of forest, wetland and lake ecosystem was negligible among communities. Some households started to look for alternatives such as seasonal labour jobs or seasonal migration outside the Rupa watershed area.

Similarly, when LI-BIRD initiated In-Situ project in the mid-1990s, the Rupa watershed farmers had already switched to the habit of using modern agricultural technologies – such as improved crop varieties, chemical fertilizers, insecticides and pesticides, usually promoted by the government's line ministries and departments but also many sponsored agricultural projects which were parts of the integrated rural development projects. Many local crop varieties were no longer part of the regular agriculture production system and their genetic resources were fast eroding, and some crop varieties/landraces were at the verge of being extinct. The importance of agrobiodiversity conservation to sustain agroecosystem was poorly understood and applied.

The unsustainable agricultural practices and use of Rupa watershed resources were not only affecting crop biodiversity, but also wetland biodiversity. Increased use of chemical fertilizer, insecticides and pesticides in the upland farmland was having negative impact down-stream – particularly Rupa Lake water and local fish varieties such as Sahar and Kaande, and the habitat of local aquatic plants, such as wild rice, white lotus and wetland birds. Consequently, functioning of the agriculture and wetland ecosystems in the Rupa watershed had been seriously curtailed.

3.3 Approaches and Measures Adopted to Address the Problems Facing the Rupa Watershed

To improve the environmental conditions and to promote sustainable agricultural practices, both BTRT and In-Situ projects focused on the assessment of resource degradation and management problems, raising awareness on the problems facing the watershed regeneration and their potential solutions and actions required. For planning and implementing project activities, the BTRT project formed and worked through Community Development and Conservation Committees (CDCC) in each village Panchayat (later Village Development Committee or VDC) to mobilize the local people and with whom the field staff worked closely. The CDCC members and field staff were provided with training on social and technical skills to mobilise local communities using a range of Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) methods, tools and techniques. Once the plantations were established on the deforested land, the BTRT project

negotiated with the Kaski District Forest Office to form forest user groups and to formally hand over the forests to these groups to use and manage as community forests. Today, some 14 Community Forest User Groups (CFUGs) are managing forest as community forest in the Rupa watershed area. The BTRT project also assisted to form local organizations – such as KiDeKI (Kisan Dekhi Kisan Samma or Farmers-to-Farmers) to help the farmers to continue to protect and promote sustainable agricultural practices.

The In-Situ project initially worked with the CDCCs and later formed new groups where necessary. In the initial years, using the various RRA and PRA approaches, the project work focused on assessing the watershed agrobiodiversity situation, engaging farmers and community organizations in raising awareness, and gradually on more specific activities, such as identification and recording of the local crop varieties, and selection of specific crop varieties for enhancing traits through a technique called Participatory Plant Breeding (PPB), seed management and related action research. The project successfully piloted Community-based Biodiversity Management (CBM) approach – thereby establishing participatory approach to empower communities and local institutions for managing biodiversity for social, economic and environmental benefits (Sthapit et al, 2006). Building on the In-Situ project work, the Community Biodiversity Register (CBR) project supported to form a local community-based organization known as 'Jaibiksrot Samrakchan Abhiyan/JSA' (literally known as Community Biodiversity Conservation Movement), bringing together 17 associated groups, 1 Community Development Committee, 1 NGO (KiDeKi) and 2 Cooperatives (Pratigya and RLRFC) as JSA's members.

The IUCN supported Community-based Wetland Management (CWM) project, in collaboration with the CBR project, initiated wetland conservation to enhance livelihoods of wetland communities. The project assisted the RLRFC in developing community-based wetland management plans, with special provision for the *Dalits* and indigenous communities to participate and benefit. The key principle adopted was conservation through sustainable utilization of the Rupa Lake resources e.g., protecting critical water source areas by planting trees, constructing check dams, establishing green-belts outside the Rupa Lake boundary and setting aside areas for habitat for wetland plant and animal species such as wild rice, white lotus and wetland birds. The CWM project also assisted RLRFC on establishing a payment for watershed services mechanism for sharing the Rupa Lake income with upstream communities who were not the cooperative members, but were making contribution to Rupa Lake restoration.

The other two projects built their programmes on the above achievements and helped to further strengthening and advancing the local biodiversity conservation and livelihood enhancement work e.g., capitalizing on successful results and learning of the earlier projects to establish market linkages for the local agrobiodiversity products, and establishing a Biodiversity Information Centre (BIC) in Sundaridanda for use by students, researchers and domestic and international tourists/visitors, and using the income generated to support local conservation and development work.

3.4 Major Changes Perceived, Observed and Recorded (Situation of Rupa Watershed Post 2010s)

This section summarises major changes that have occurred in the Rupa watershed area over the years as a result of the various interventions and spontaneous developments, and as a result of the response of the Rupa watershed inhabitants to these development initiatives.

3.4.1 Transformation of the Rupa Watershed

Over the years, the entire landscape of the Rupa watershed has been completely transformed. Most of the deforested and degraded forest on the hill slopes and ridges have been rehabilitated, and most of the natural streams and ponds and Rupa Lake

have also been restored, thereby enhancing the Rupa watershed's overall water recharging capacity. Similarly, the rate of top soil erosion, frequency of landslides and forest fires have been reduced to minimum, thereby reducing greatly the rate of Rupa Lake sedimentation and siltation. There is now regular flow of clean water from the steams to Rupa Lake year round, and the Lake water turbidity is significantly reduced. The previously disappeared wild plants, animals and birds have returned to the forest and wetland areas. As a result of these improvements, all the three ecosystems - forest, agriculture and wetland – in the Rupa watershed area have been restored and they are functioning and providing services to the Rupa watershed inhabitants and other people generally.

3.4.2 Reduced Pressure on Land and Related Natural Resources

One of the significant changes relate to the reduced pressures on both public (common) and private land. With increased access of households to more off-farm employment and income means the concerned households do not have to depend on farmland for living in the same way as they did in the past. Further, more household members engaging in off-farm jobs means fewer people are now available to work on farmland and to look after farm animals. The abandoned agricultural lands are now covered with regenerated trees and grasses. Most households now have sufficient firewood on their private farmland and do not collect firewood from the public forests and more and more households are now switching to LPG cooking gas. Household maintain fewer animals and are mostly staff-fed thus reducing the grazing pressure on forestland.

3.4.3 Land Use and Land Cover Change

As stated in Section 2.3.4 above, in the mid-1980s, the majority of the Rupa watershed public forestland was completely devoid of trees and whatever forests were remaining then, they were also in a much degraded condition. All those deforested and degraded forestland areas are now covered with dense forests. An attempt was made to compare the land use change in the Rupa watershed area using satellite images of three different times, namely 1977, 2000 and 2020. The result is presented in Table 3. The area under both the forest and abandoned agricultural land has increased. The forest area increased from 965.81 ha in 1977 to 1,383.51 ha in 2000 and 1,673.23 ha in 2020. The abandoned agriculture land increased from 0 ha in 1977 to 9.51 ha in 2000 and then to 24.14 ha in 2020.

However, agricultural land decreased from 1,634.45 ha in 1977 to 1,210.88 ha in 2000 and then to 909.20 ha in 2020. Similarly, the area under water body decreased from 107.11 ha in 1977 to 103.45 ha in 2000 and 100.82 ha in 2020. One of the explanations for reduction in area under agriculture is the decision of increasing numbers of farmers to leave (or abandon) parts of their agricultural land uncultivated due to shortage of agricultural labour. Similarly, an explanation for decrease in area under water body could be due to dense forest cover, making it difficult for some water areas (streams, ponds etc) to show up in the satellite image.

Table 3: Land use and land cover change in the Rupa watershed area

Land type /Year	Year		
	1977	2000	2020
Forest area (ha)	965.81	1,383.51	1,673.23
Agriculture land (ha)	1,634.45	1,210.88	909.20
Water body (ha)	107.11	103.45	100.82
Uncultivated/abandoned agriculture land (ha)	0.00	9.51	24.10

3.4.4 Biodiversity Conservation Related Change

- **Increased understanding and knowledge on local biodiversity -** As a result of the project interventions, particularly the In-Situ, CBR and CWM projects, there is now much improved understanding and knowledge of local biodiversity among the local farmers. The farmers now understand why local/indigenous crop varieties, plants and wild birds and animals, which they did not value earlier, are so important and how they should be protected and conserved for future generations.

- **Recording and documentation of local plants, animals, birds and crop varieties -** The In-Situ and CBR and other subsequent projects, with support from local organizations, such as JSA and RLRFC, carried out an inventory of different local crop varieties, plants, animals and birds found in the Rupa watershed area and prepared a list and also recorded information on their use, habitat and other characteristics. Accordingly, as of now, there is documented information on some 440 crop varieties, including 111 wild medicinal plants and 92 wild food species.

- **Regeneration of previously disappeared local crop varieties, plant and animal species, and selecting/ prioritizing for conservation of genetic resources -** One of the significant, and probably the most important, contributions that In-Situ and CBR projects have made is the way they have - with support from local organizations - managed and mobilized the resources (local knowledge and skills) for reviving the previously disappeared local crop varieties, and for the conservation and promotion of wild plant, tree and animal species of the forest, wetland and agricultural ecosystems. To ensure that these rare crop varieties, plant and animal species are not lost again and to conserve their genetic resources, local farmers and project staff jointly prioritized crop varieties for conservation and promotion. Some local crop varieties included in the initial mandatory list were *Anadi* (local sticky rice), *Kodo* (finger millet), *Pidhaloo* (taro) and *Ghiraula* (sponge gourd). Later they added few more local crops, including *Pokhareli Jethobudho* (rice), *Kaguno* (foxtail millet), *Latte* (amaranth) and *Kakro* (local cucumber) and few other vegetables, such as local beans. The Participatory Plant Breeding (PPB) group, which the In-Situ project formed for undertaking crop breeding work, is reported to have improved 12 landraces of rice through breeding and selection.

  Similarly, the project staff and RLRFC have identified a number of valuable aquatic plant, animal and bird species that needed to be protected and conserved. They set aside areas for protection and conservation of valuable wetland species and their habitat, including wild rice (*Oryza rufipagon*), white lotus (*Nelumbo nucifer*), and indigenous fish, such as Sahar and Kaande, and migratory birds. Some other local organizations later developed interest in becoming involved in conservation work. For example, the Sundaridanda Community Development Committee initiated wild orchid conservation work through the establishment of orchid nursery and exploring markets for local orchid, and at the same time use the nursery for raising public awareness.

- **Community-based Biodiversity Information Centre -** In 2015, JSA – with funding support from Swiss ReSource Foundation (via LI-BIRD), established in Sundaridanda Community-based Biodiversity Information Centre (BIC) to display the work on local biodiversity, for use by farmers, students, academics and development professionals, and general visitors and public. It includes information relating to various goods and services provided by the Begnas (another lake located adjacent to Rupa) and Rupa watersheds, and displays specimens, photos and written information on various crop varieties, vegetables and a range of other flora and fauna of the two watershed areas. The BIC also provides information on daily, monthly and annual climatic data, as well as information on Good Agriculture Practice (GAP). The effort, such as this, to put together and display information on local biodiversity in such consolidated manner is a unique example and probably the first of its kind in Nepal.

3.4.5 Livelihoods Related Change

Although most of the past project interventions were driven primarily by environment protection and conservation objectives, their programmes and activities also contributed to help enhance local

livelihoods, one way or another. For example: during 1985-1997, the BTRT project created opportunities for local people to earn additional income by involving them in tree planting, forest protection and soil conservation work such as construction of check dams, retaining walls on gullies and water catchment areas and hill slope terrace improvement. Thousands of men and women were employed every year on daily wages during rainy seasons, for tree planting activities, and during the dry season for soil conservation work. In addition, hundreds of local people were employed on monthly salaries to work as nursery technicians and plantation/forest watchers.

Similarly, through promoting the conservation of local crop varieties and their genetic resources, the In-Situ and CBR projects were in fact assisting to ensure food security (hence livelihoods) of both the present and future generations. Not only did these two projects identify and help conserve valuable, nutritious local crop varieties that were on the verge of extinction, they also used seeds of such rare local crop varieties to multiply for distribution to other farmer. They also initiated seed exchange programmes and use the BIC as outlet to buy and sell the seeds of these rare local crop varieties and vegetables.

Apart from the above, there are some specific initiatives deliberately designed to directly assist towards enhancing local livelihoods, four of which are briefly described below:

- **Enhancing local livelihoods through community-based biodiversity management fund –** JSA, with the seed money from CBR project, has created a Community-based Biodiversity Management Fund (CBM Fund) to support its member groups – and through them - to enhance livelihoods of their member households. All 17 JSA groups have access to this fund. Each group initially receives NPR 50,000 for a fixed period of time, with low interest rate and without any collateral. The concerned group then uses this money to lend to its member households (approximately NPR 5,000 per household), with low interest rate and with no collateral. The concerned households need to use the money for income generating activities, such as goat farming, bee keeping, vegetable production etc. Some group members reported to earn as much as NPR 150,000 annually from the initial loan of NPR 5,000. The CBM fund has increased from NPR 635,000 in 2015 to over NPR 1.4 million in 2019. In 2019, on the request of the member groups, JSA decided to increase the loan amount from NPR 50,000 to 100,000.
- **Enhancing local livelihoods through fish production and marketing -** Another example of successful local livelihoods enhancement is the way in which RLRFC has been managing Rupa Lake ecosystem and way in which the RLRFC is using Rupa Lake for production, harvesting and sustainable utilization of fish resources to improve the income of its member households. RLRFC has rapidly grown and expanded its activities. Its membership increased from 38 in 2004 to 854 in 2019, with the share value rising from NPR 5,000 to 40,000 per share in 2019, and more than NPR 150 million worth of fixed asset, fish stock and cash, and with 24 full time staff. The economic status of poorer fishers (indigenous Jalari and Majhi households), who previously barely earned enough to meet day to day household needs, has been uplifted to the level, where their children, these days, attend colleges.
- **Enhancing livelihoods of smallholders and landless -** Another successfully piloted approach was the support provided to smallholder farmers and landless with the aim of enhancing livelihoods by capitalizing on local agrobiodiversity products and utilizing them sustainably. This was done by identifying and selecting a group of local smallholder farmers and landless people, especially women, and organizing training courses for them to produce processed agrobiodiversity products such as Masaura and Gava from taro as well as on packaging of the processed products, with proper labels and information of the products. The project also assisted in identifying 'niche' market for such products produced by women groups and in building partnership with the private sector.
- **Biodiversity Information Centre (BIC) -** Enhancing livelihoods through serving as intermediary between farmers and consumers - In addition to using the BIC to disseminate local biodiversity related information, the JSA has also been using the BIC as a place for buying and selling locally produced agrobiodiversity products.

The local farmers, particularly the smallholders, appear to benefit more from this facility as selling small quantities directly in the market demands additional time, effort and cost. The agrobiodiversity products, which the smallholder farmers are selling through the BIC are mostly *Pokhareli Jethobudho* and *Anadi* rice, *Kaguno*, local beans, processed items of taro and local honey.

3.4.6 Commercialization of Selected Local Agrobiodiversity Products

Farmers in the Rupa watershed area had been producing diverse local food crops and food items for generations, but mainly for household consumption and for use within the local community. The In-Situ and CBR projects explored possibility of marketing local food produce in Pokhara. It facilitated the process of developing value chain for selected food commodities. At the community level, it worked through a local cooperative (Pratigya) for collection of produce from farmers and supplying to wholesalers in Pokhara. Within a few years, the cooperative was selling more than 4.5 tons of *Anadi* rice and 200 kg of taro products annually, and the number of farmers growing and the area used to grow these crops both increased rapidly. The Cooperative later installed its own rice mill, set up collection centres and collaborated with private sector for marketing.

One local woman entrepreneur (Mrs Maina Thapa), member of Pratigya Cooperative, is now running the business in full swing, expanding it by leasing more agricultural land (left uncultivated by people now living in cities), to produce *Pokhareli Jethobudho* rice, and has started to supply this particular rice to Kathmandu and other bigger cities in Nepal. In 2019, the annual turnover from *Pokhareli Jethobudho* rice alone was more than NPR 1.2 million (approx. US$12,000), and she is earning from trading many other local agrobiodiversity products such as taro, *Anadi* rice, and a range of dairy products. This income is substantial given the national annual per capita income of only US$1,047. Mrs Thapa's son, who was working in Dubai, decided to return to Nepal to join hands and further strengthen and expand the business. A more recent assessment shows that in 2019, the local farmers from Rupa watershed area had produced more than 10 tonnes of *Pokhareli Jethobudho* rice, 2.5 tonnes of *Anadi* rice, 2 tonnes of *Kaguno* (foxtail millet), 1 tonne of taro, and 100 kgs of local honey.

Similarly, realising the importance and need for conservation, promotion and sustainable utilisation of local/ indigenous species, RLRFC also decided to produce and promote local fish species (Sahar) in Rupa Lake, and supply them to market. The RLRFC bought separate land to construct hatchery ponds to produce fingerlings of local fish for supplying to the Lake. In 2019, the annual production and sale of the local fish had increased to more than 4.6 metric tonnes. As a result, not only did such a move increase the RLRFC's own and its member's income, it also helped to conserve local fish species, the fish habitat and the habitat of other wetland species.

For promotional work, farmers and cooperatives were encouraged to take part in various market fairs and display and sell their products. Local FM radios were used to raise awareness on such products and their nutritional values. As a result, the Rupa watershed agrobiodiversity products started to gain popularity among the consumers.

3.4.7 Branding Local Agrobiodiversity Products

More recently, in order to take the Begnas and Rupa watershed's conservation and development effort to a next level, JSA with support from LI-BIRD and funding assistance from Swiss ReSource Foundation started to give a brand name to the local agrobiodiversity products. They came up with an idea called 'Landscape Branding'. The idea is to finding a way to reflect special characteristics of the Begnas and Rupa watershed landscape through the landscape brand to promote local agrobiodiversity products of the areas and enhance the household and local economy. All the local agrobiodiversity products that are produced in the Begnas and Rupa watershed area are sold with this logo. The work is still in progress, but the agrobiodiversity products with this brand logo are gaining popularity.

3.4.8 Community Development Through Integrated Biodiversity Education and Tourism

Following the establishment of the Biodiversity Information Centre (BIC), and seeing the increased inflow of domestic and foreign tourists into Rupa watershed area, particularly in Sundaridanda where BIC is located, the Sundaridanda Community Development Committee, decided to use this as an opportunity to promote tourism by constructing a view tower for use by tourists, and for generating income which could then be used to meet their objective of local community development. It sought funding from the various local organizations, including the JSA and its member organizations. The Committee constructed the View Tower next to the BIC building, using one entry door to both the View Tower and the BIC. In three years, by the end of 2019, the Tower and the BIC had been visited by more than 42,990 domestic and international visitors, raising over NPR 736,300. The Committee uses the money to cover cost of maintaining the Tower and BIC (including salary of two full-time staff) and to support a local school by providing scholarships for underprivileged children. The portion of the income also goes to the 'Lake Conservation Fund' for a range of community development activities. This is a unique example of on-the-ground action to integrate conservation, tourism and community development.

3.4.9 Adoption of Ecological Farming/Environment Friendly Agricultural Practices

Rupa watershed farmers, since the inception of the BTRT and In-Situ projects have been encouraged to follow agricultural practices that are more environment friendly. This means using not only local/ indigenous varieties of crops and vegetables, but also reducing the use of chemicals, insecticides and pesticides, increase use of compost/farm yard manure and biological pesticides. The LI-BIRD staff in recent years have also been advocating for organic farming and encouraging chemical free integrated home gardening in the Rupa watershed area.

On the other hand, for some time, the downstream farming communities, especially those involved in fish business, started to pressurise on the upland farming communities to stop using chemical pesticides that could jeopardise their fish production business. Similarly, the upland farmers, involved in local honey production business have also started to put pressure on their fellow upland community members to stop using chemical pesticides to avoid adverse impact on local honey production business. As a result of these developments, the Rupa watershed farming practices is increasingly becoming environmentally friendly.

3.4.10 Emerging Challenges and Issues

While the above observations and records show positive aspect of change in the Rupa watershed area, in recent years some new challenges and issues have started to emerge. Three of these emerging challenges are discussed briefly below.

- **Human-wildlife conflict -** The rehabilitation of the deforested and degraded forest area, and bringing the forest ecosystem back into its proper functioning is indeed positive achievement. However, the growth of planted trees into dense forests and therefore improved environment has brought with it a new challenge for the watershed habitants. Not only have now the previously disappeared wild animals returned to the regenerated forests, some of these wild animals, especially monkeys and porcupines, have started to damage food crops grown in the farmland. The problem is getting serious, and is likely to get more serious in the future due to wild animals getting closer to farmlands as the trees regenerated on the abandoned agricultural land grow into dense forest. In some parts of Nepal, some companies are reported to have introduced crop and livestock insurance policy, but this is yet to happen in the Rupa watershed area.
- **Rupa dam project –** With persistent effort of RLRFC leaders, the government of Nepal, three years ago, approved the Rupa dam project. The RLRFC leaders and members wanted to see Rupa Lake developed like Begnas and Fewa Lakes by constructing a dam, and promote tourism as is the case in Fewa and Begnas Lake. The government has allocated NPR 4.52 billion

for the construction of Rupa dam. This is certainly a positive gain for the Rupa inhabitants, however, for scheme like this, it is important for the government and RLRFC leaders to ensure that the construction of Rupa dam does not undermine the conservation and other development efforts of local people which have taken years to build.

- **COVID-19 -** The recent outbreak of COVID-19 pandemic globally is likely to have profound impact on the use and management of ecosystems and therefore on rural livelihoods. In Nepal, tens of thousands of migrant workers from overseas are now returning to rural villages. GoN is currently engaged in adopting measures to prevent the spread of disease and in relief operations, however, there is also a need to look into the implications of COVID-19 beyond these short-term measures. Many returnee migrants are likely to stay back in their villages, resume farming and seek other form of local employment, to protect against high levels of livelihood insecurity and vulnerability, thereby placing additional pressure on the ecosystems. There is therefore a need for the JSA and RLRFC and other concerned stakeholders to consider the challenge presented by COVID-19 pandemic and ensure sustainability of both the ecosystems and local livelihoods.

4. METHODOLOGY

4.1 Selection of Study Site

LI-BIRD and UNEP-IEMP/IGSNRR-CAS team conducted a joint field visit in October 2019 and identified Rupa Lake watershed area as appropriate demonstration site for conducting the case study. Two local organizations i.e. Rupa Lake Restoration and Fishery Cooperative (RLRFC) and Jaibiksrot Samrakchan Abhiyan (JSA), who implemented the large majority of projects to build resilience, and are directly involved in the management of Rupa Lake ecosystem and conservation and utilization of agrobiodiversity surrounding Rupa Lake watershed respectively were chosen. In this case study, RLRFC and JSA are regarded as two initiatives crosscutting the projects implemented to build resilience. Therefore, the households covered by these two organizations formed the basis for planning and conducting the two case studies.

The household survey questionnaire complemented by FGD and KII comprised the primary instrument to elicit data from the respondents. In addition to the household questionnaire survey, another methodology known as 'process documentation' was also planned and executed. While the household questionnaire survey focused in areas and household served by RLRFC and JSA, the process documentation focused in the case study of the two organizations (i.e. RLRFC and JSA) themselves. The process documentation aimed at drawing information on the governance and organizational functioning of RLRFC and JSA to complement and enrich the analysis of causes and underlying mechanisms for the impacts on livelihoods.

4.2 Household Questionnaire Survey, FGD and KII

A total of 240 households (120 households for each case study) were interviewed, with 99 (41%) male and 141 (59%) female respondents. For each case study, out of 120 sample households, 60 households (50%) were randomly selected from the list of


Figure 5: Enumerators interviewing farmers in Aduwabari village (Left) & FGD in Adhikari village (Right)

shareholders and member households in RLRFC and JSA respectively (Figure 5). The sample households comprised as 'participant household', which indicated that these households have participated in project interventions and benefitted in some ways from their participation. Whereas, the remaining 60 households (50%) were randomly selected as 'non-participant household' from the list of households which were non-shareholder of RLRFC and non-member of JSA, but dwell in the given geographic location i.e. Rupa watershed area.

4.2.1 Characteristics of Respondents and Households Involved in Household Survey

The information with regards to the characteristics of 'respondents' and 'households' involved in the household survey in both case studies (RLRFC and JSA) is presented in Table 4.1 and 4.2 respectively. Table 4.1 shows that the characteristics of respondents in case of RLRFC follow a similar

Table 4.1: Characteristics of respondents involved in survey, 2019

Respondent Parameters	Parameter Category	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Gender	Male	36 (60%)	24 (40%)	18 (30%)	18 (30%)	54 (45%)	42 (35%)
	Female	24 (40%)	36 (60%)	42 (70%)	42 (70%)	66 (55%)	78 (65%)
Age	< 35 Years	3 (5%)	9 (15%)	16 (27%)	14 (23%)	19 (16%)	23 (19%)
	>36-60 Years	43 (72%)	37 (62%)	36 (60%)	34 (57%)	79 (66%)	71 (59%)
	>60 Years	14 (23%)	14 (23%)	8 (13%)	12 (20%)	22 (18%)	26 (22%)
Education	Illiterate	3 (5%)	6 (10%)	5 (8%)	6 (10%)	8 (6%)	12 (10%)
	Basic	18 (30%)	26 (43%)	14 (23%)	23 (38%)	32 (27%)	49 (41%)
	Secondary	33 (55%)	25 (42%)	33 (55%)	28 (47%)	66 (55%)	53 (44%)
	College	6 (10%)	3 (5%)	8 (13%)	3 (5%)	14 (12%)	6 (5%)
Caste/ Ethnicity	*B/C/T*	45 (75%)	51 (85%)	43 (72%)	49 (82%)	88 (73%)	100 (83%)
	Janajati	11 (18%)	5 (8%)	15 (25%)	2 (3%)	26 (22%)	7 (6%)
	Dalits	4 (7%)	4 (7%)	2 (3%)	9 (15%)	6 (5%)	13 (11%)
	Minorities	-	-	-	-	-	-

Note: The figures in parenthesis include percentage of responding households

pattern for age, educational status and ethnicity between participant and non-participant samples, with significantly higher number of women respondents in non-participant sample. In case of JSA, participant and non-participant samples follow similar pattern for age, educational status and gender, with significantly higher number of *Dalit* respondents in non-participant sample. 70% respondents in both participant and non-participant samples were women, which is corroborated by a baseline study conducted in the area (Rana et al., 2020).

Table 4.2 shows that the characteristics of 'households' in case of RLRFC follow the similar pattern in terms of family size, number of children and land holding between participant and non-participant samples, with significantly higher number of economically active population and migrant workers in participant category. In case of JSA, participant and non-participant households follow similar pattern in all parameters, with participant households owning slightly larger agricultural land than non-participant households.

4.3 Approach, Method and Tools Used for Process Documentation

For the process documentation of RLRFC and JSA, two main approaches i.e. FGD and KII were adopted. The aspects (or areas) of the RLRFC and JSA that process documentation focused included the following: (i) the context and setting in which the RLRFC and JSA have been operating; (ii) the conditions that triggered the establishment of the organizations and ways they evolved over the years, key people and their roles in setting-up of the organizations and support for the organizations' continued existence and functioning; (iii) the organizational goals and objectives, their achievements and impacts; (iv) the key actions/

Table 4.2. Characteristics of households involved in survey, 2019

Household Parameters	Parameter Value	RLRFC (n-120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Family size	Number of members	5.9±0.4 (60)	5.6±0.4 (60)	5.8±0.3 (60)	5.9±0.3 (60)	5.9±0.3 (60)	5.7±0.3 (60)
Number of children*	Children per HH	2.2±0.2 (35)	2.3±0.3 (47)	2.0±0.2 (46)	2.1±0.2 (37)	2.1±0.1 (81)	2.2±0.2 (84)
Number of labours**	Economically active population	4.7±0.3 (59)	3.9±0.2 (60)	4.3±0.2 (60)	4.3±0.3 (60)	4.5±0.2 (119)	4.1±0.2 (120)
Land holding	Area per HH	0.5±0.1 (59)	0.6±0.1 (60)	0.5±0.1 (60)	0.4±0.0 (60)	0.5±0.0 (119)	0.5±0.0 (119)
Number of migrant workers	Migrant workers per HH						
	Near home	1.8±0.2 (38)	1.7±0.3 (15)	1.6±0.1 (36)	1.5±0.2 (23)	1.7±0.1 (74)	1.6±0.1 (38)
	Overseas	1.8±0.2 (19)	1.2±0.1 (30)	1.4±0.2 (26)	1.2±0.1 (26)	1.6±0.1 (45)	1.2±0.1 (56)
	Within country	1.7±0.3 (17)	1.6±0.2 (27)	1.5±0.2 (13)	2.2±0.3 (17)	1.6±0.2 (30)	1.8±0.2 (44)
	Total	2.6±0.2 (51)	1.9±0.1 (55)	2.1±0.2 (55)	2.2±0.2 (48)	2.3±0.1 (106)	2.0±0.1 (103)

Note: The figures in parenthesis include number of responding households

*Children is calculated under age 18 as per the UNFPA in Nepal (https://www.unicef.org/nepal/children-nepal)

** Economically Active Population (EAP) is calculated age between 15-64 as per the UNFPA, Nepal (https://nepal.unfpa.org/sites/default/files/pub-pdf/Nepal%20Population%20Situation%20Analysis.pdf)

decisions that proved to be milestones for a major change in the organizations' operation and functioning or shift in the overall focus and direction of the organizations' programmes and activities; (v) the factors that have been enabling or resisting for the functioning of the organizations; and (vi) challenges and constraints that the organizations faced over time and ways they were addressed. A total of 13 FGDs and 8 KIIs involving 119 people (of which 53 were women) were conducted as part of RLRFC and JSA process documentation.

4.4 Data Analysis

The data analyses for both case studies, including the combined data analysis of JSA and RLRFC (i.e. 240 households) were conducted, and results presented and interpreted accordingly. The analyses were done using Statistical Package for Social Sciences (SPSS) and MS Excel. The dataset contained variables having different types of data measurement scale: nominal (e.g. gender of respondent, caste/ethnicity, occupation, etc.); ordinal (e.g. education status, level of satisfaction with public services, etc.) and ratio (e.g. income, expenditure, production, productivity, etc.). As a general rule of data analysis, we produced frequency tables for variables with nominal and ordinal scale values. Likewise, for variables with ratio scale values, we produced descriptive statistics tables (mean, median, standard deviation, range). These preliminary analyses allowed us to notice how the observed data are distributed in the sampled households, outliers on the data, and also to ensure that data followed normal distribution.

The overarching objective of the study is to demonstrate that project interventions have positive and lasting effects on people's livelihood and well-being. Therefore, the Null Hypothesis adopted is: Ho = There is no difference between participating and non-participating samples in terms of livelihood capitals, livelihood strategies and livelihood outcomes. Hence, the basic tenet of data analysis has been guided by the comparative results of participating versus non-participating samples, and in some cases overall results are also presented and interpreted.

In order to test the above hypothesis, we produced comparative analyses of tables comparing the values of the parameters/variables between participating and non-participating groups. For variables having nominal and ordered scales, a Chi-square test (χ^2) was performed, and the Pearson Chi-square value and p-value (statistical significance at 95% and 99% confidence interval, i.e. $p<0.05$ and 0.01) were observed. Similarly, for variable with interval and ratio scale, a t-test for Equality of Means with/without equal variance was performed, and statistical significance was analyzed at 95% and 99% confidence interval. The above analyses were conducted to observe whether or not there were any statistically significant differences between participating and non-participating households for access to livelihood assets or resources, livelihood strategies adopted, and livelihood outcomes realized.

We investigated the skewness, histogram, normal Q-Q plot and box plot to observe the normal distribution of the sampled data. While performing the above analyses, we realized that some variables/data, especially income and value of assets (house and land plots) did not follow the 'normal distribution' norm, which implied that the data could not be directly inputted for performing parametric tests. As suggested by Douglas Curran-Everett (2018), data transformation using log transformation for positive skewed data has to be accomplished prior to running the test, which we did. Therefore, in case of income and assets valuation, the results are derived on log transformation data.

Finally, to establish the causal-relationship between various independent parameters/variables (participating/non-participating households, individual traits, household characteristics, livelihood capitals/resources) to livelihood outcomes (income, expenditure, energy use, agricultural productivity, food intake), a regression analysis was performed. A separate regression analysis for JSA and RLRFC was not possible given small sample size, therefore, samples from both the case studies have been combined to have an overall sample size of 240 households. Several regression models were generated to get the best fitted line of the residual

with livelihood outcome as dependent variable with multiple independent variables like participation, individual traits, household characteristics and livelihood capital/resources. The regression model depicts the variance of each predictors explained on the outcome variable.

The multiple regression model was applied on the ratio scale outcome variable (dependent variable) and multi-nominal regression was applied which has nominal scale outcome variable. The larger sample size is better to predict the outcome. In general, 20 response per predictor variable is required (Bujang et al., 2017) for multiple regression, which was an issue in sample of individual case study. Correlation between independent variables, Variance Influence Factor (VIF) and Tolerance values were observed to check the multicollinearity. The strong correlation (r=0.7) between predictor variables and VIF >10 indicates the multicollinearity which violets the regression assumption. We excluded such independent variables from the model fitting.

The DFID has developed a sustainable livelihood framework which is one of the most widely used livelihoods frameworks in development practice. The study team used the DFID's sustainable livelihood framework (Figure 6) as a guide, and therefore, the key findings and the analysis of causes and underlying mechanisms for the impacts on livelihoods are organized and presented along DFID's Sustainable Livelihood Framework i.e. livelihood capital → livelihood strategy → livelihood outcome.

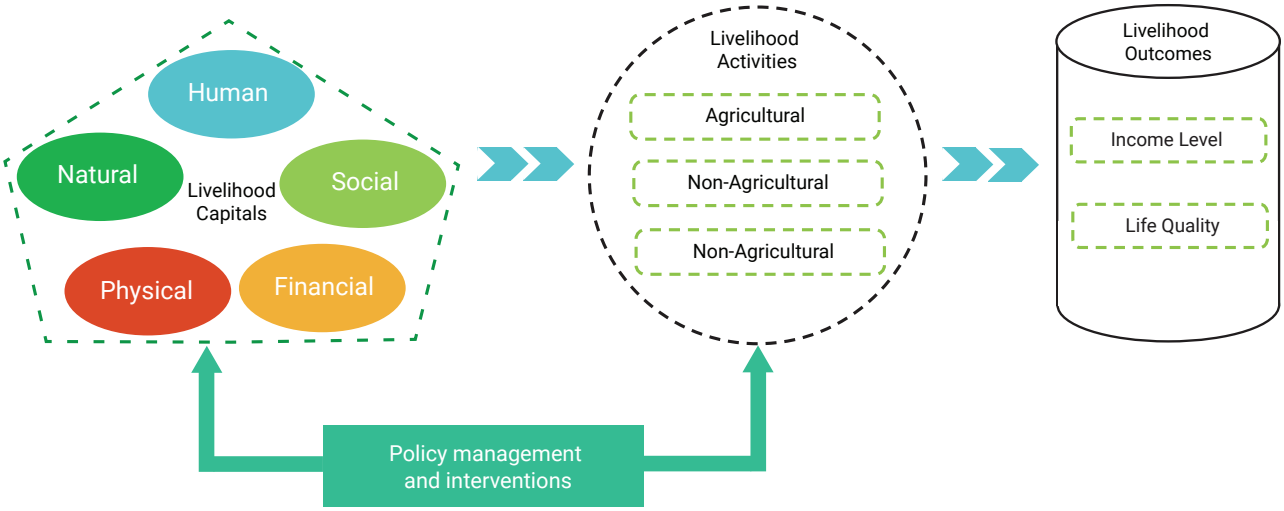

Figure 6: Analytic framework for sustainable livelihoods in rural areas (adapted by UNEP-IEMP from DIFD's Sustainable Livelihoods Framework - DFID, 1999)

5. FINDINGS

5.1 Livelihood Capital

5.1.1 Natural Capital (Land holding and access to irrigation)

Amongst the five livelihood assets, we analyzed how the endowment of natural capital, viz. land area, which comprises a primary asset for food security and income in agrarian society, differ between participant and non-participant households for two case studies (Table 5).

Table 5 indicates that all households own land, and average land ownership per household between participant and non-participant households follow a similar pattern, having statistically non-significant difference ($p>0.05$). Khet and Bari land are the most common lands owned by majority of households whereas orchard and private forest is not common at household level. Kharbari is more prevalent in non-participant group (n=37; 31%) as against participant group (n=30; 25%). As compared to sharing-in land, leasing land is increasingly becoming common phenomenon especially in areas where outmigration of youths is widely prevalent. The average land holding for the study area stands at 0.5 ha, which is comparable to the national average of 0.47 ha (CBS, 2013), divided into more than six parcels (almost twice the national average of 3.2 parcels) making the management of land a highly cumbersome and inefficient operation.

5.1.2 Physical Capital (House assets, ghaderi assets, household utilities, access to public services)

The study collected relevant information on the above parameter at household level (Table 6). The findings indicate that almost all households own at least one house, however, owning plots (*Ghaderi*) was not common (figure ranges from n=9 to 23, i.e. 15% to 39%) though participant households tend to fare better in both the case studies (Table 6). Ownership of agricultural land is universal across study sites.

Irrespective of the two case studies, properties owned by participant group have higher value than the ones owned by non-participant groups. The difference is more striking in case of RLRFC where average value of house is worth NPR 12,014,000 (approximately USD 97,674), which is 4.9 times more valuable than the one owned by non-participant group. In both the cases, plots (*Ghaderi*) owned by participant households had higher value than the similar plots owned by non-participant households, but the difference in valuation is statistically non-significant ($p>0.05$). Whereas, the valuation for houses and agricultural land owned by participant group vs non-participant group is statistically highly significant ($p<0.01$). This clearly is the reflection of location advantage of participant households' settlement against non-participant group settlements.

Table 5: Average land holding area (ha) of the responding households in the study area, 2019

Land type	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Khet	0.3±0.0 (49)	0.3±0.0 (51)	0.3±0.0 (52)	0.3±0.0 (40)	0.3±0.0 (101)	0.3±0.0 (91)
Bari	0.3±0.0 (47)	0.2±0.0 (57)	0.2±0.0 (54)	0.2±0.0 (55)	0.2±0.0 (101)	0.2±0.0 (112)
Orchard	0.1±0.0 (8)	0.1±0.0 (6)	0.1±0.1 (16)	0.03±0.0 (15)	0.1±0.0 (24)	0.04±0.0 (21)
Forest	0.1±0.0 (3)	0.2±0.0 (10)	0.1±0.0 (11)	0.1±0.0 (7)	0.1±0.0 (14)	0.1±0.0 (17)
Kharbari	0.3±0.1 (16)	0.3±0.1 (28)	0.2±0.0 (14)	0.2±0.0 (9)	0.2±0.0 (30)	0.2±0.1 (37)
Shared-in land	0.3±0.1 (8)	0.3±0.1 (7)	0.3±0.1 (12)	0.4±0.2 (7)	0.3±0.1 (20)	0.4±0.1 (14)
Leased-in land	0.3±0.0 (10)	0.3±0.1 (12)	0.5±0.3 (19)	0.3±0.1 (16)	0.4±0.2 (29)	0.3±0.0 (28)
Total	0.5±0.1 (59)	0.6±0.1 (60)	0.5±0.0 (60)	0.4±0.0 (59)	0.5±0.0 (119)	0.5±0.0 (119)

Note: Figure in the parenthesis indicates the responding HHs

Table 6: Average value of household capitals across the case study sites, 2019

Household capital	RLRFC Average value (NPR in '000) of assets		JSA Average value (NPR in '000) assets		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Houses	12014±2655 (58)	2457±479 (60)	5224±721 (60)	3086±411 (59)	8552±1386 (118)	2769±316 (119)
Ghaderi	13382±4721 (23)	5751±874 (14)	6105±768 (19)	4055±637 (9)	15923±4275 (42)	5392±668 (23)
Land Area	24844±4031 (56)	4807±747 (60)	15357±1909 (59)	9280±1131 (59)	20881±2381 (115)	7386±808 (119)
Total	40609±5723 (59)	8606±1096 (60)	30450±5042 (60)	16522±3118 (59)	34280±3465 (119)	11197±983 (119)

Note: Figure in the parenthesis indicates the responding HHs

Another dimension we looked into in physical capital is access to irrigation facility for agriculture land, which make agriculture more productive, predictable and resilient. The data show that farmers in RLRFC group (n=66; 55%) as compared to JSA group (n=60; 50%) have higher percentage of households with access to irrigation facility. Disaggregated data indicate that more number of non-participant households (n=37; 61%) have access to irrigation facility as compared to participant households (n=29; 48%) in the RLRFC group, whereas reverse was true for the JSA group (participants=36; 30% and non-participants=24; 20%).

5.1.3 Human Capital (Access to Education)

The analysis of human capital entailed exploring the educational status of economically active population (15–64 years) as presented in Figure 7. Generally speaking, education status follows a similar pattern for participant and non-participant population except in case of college education, where participant group has visibly higher proportion and this pattern is consistent across both the case studies. Less than 5% of the economically active workforce are illiterate (cannot read or write) and another 14-18% have basic level education (up to class 8) indicating that these workforce are most probably suitable only as unskilled labour force destined for low paid physical-oriented tasks. Slightly over half of the workforce (48-59%) has secondary level of education (up to class 12), which is a prerequisite for vocational training and skill-oriented jobs in the market. This category of workforce may be self-employed or work in factories (as mason, carpenter, plumber, electricians, crafts, salesperson, etc.) or seek work overseas. Finally, 19-32% of the economically active population has

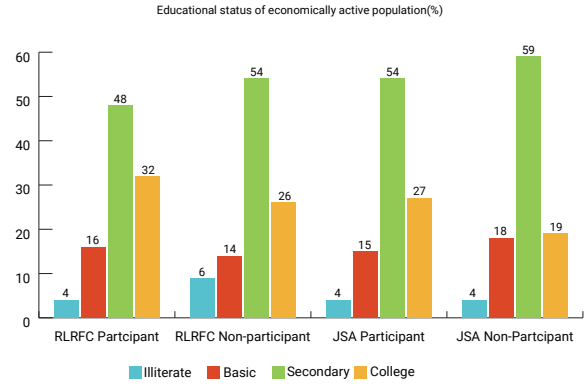

Figure 7: Educational status of economically active population (15-64 years) in the study sites, 2019

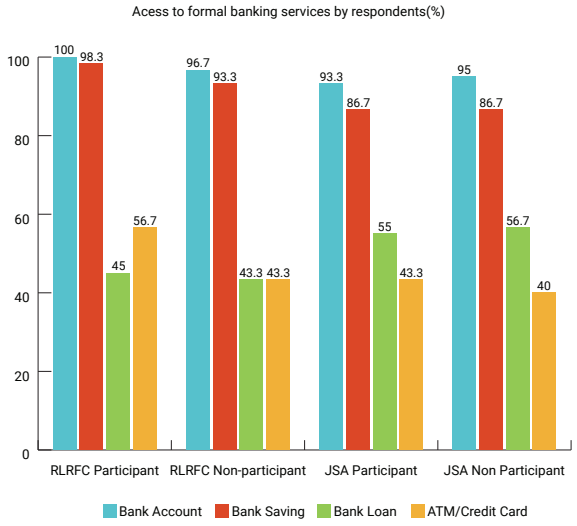

Figure 8: Access to banking services by respondents in the study sites, 2019

college/university education, with higher percentage from participant group in both the case studies. This category typically performs white collar jobs in professional, managerial and administrative fields with relatively better perks and conditions, and have better access to social networks.

5.1.4 Financial Capital (Household Access to Financial Services 2019)

The exploration of financial capital involved analysis of household members having bank account, savings in the bank, credit card, bank loan and the purpose of taking bank loan. Access to banking service is close to 100% with commendable bank savings (Figure 8) in the study area. Mainly two factors contributed to this almost universal coverage, first, is the aggressive expansion of private banking services in urban and peri-urban areas, and second the location advantage of the study sites, which are close to major urban centre – Pokhara, a regional market and administrative hub of Gandaki province. There is observable difference in terms of having ATM/Credit Card between participant households versus non-participant households (Figure 8), with former faring better.

Analysis of loan taking behaviour amongst respondents reveal that there is not much difference between participant and non-participant groups within study sites, however, noticeable difference in loan taking behaviour is observed between RLRFC and JSA respondents with latter exceeding by >10% in both the categories (Figure 8). Further analysis of loans from financial institutions reveal that respondents have multiple options (banks, relatives and friends, village mutual fund, and cooperatives) to take out loan (Table 7). Among the available options, banks, and saving and credit cooperatives are equally approached by respondents for loans. Sampled households also depend on relatives and friends on money matters, but the village mutual fund has no significance in the study area.

Amongst the sampled households, 44% and 55% households for RLRFC and JSA respectively have accessed loan from different institutions for a variety of purposes, which include building or buying a house, education of family members, starting or expanding business, investment in agribusiness, daily household living expenses, purchasing durable goods, paying for healthcare, debt servicing, meeting social obligations, etc (Table 7). Highest utilization

Table 7: Number of responses on sources and purposes of loan, 2019

Description		RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Sources of loan	Bank	15 (56%)*	8 (31%)	13 (39%)	17 (52%)	28 (47%)	25 (42%)
	Relatives/friend	7 (26%)	6 (23%)	7 (21%)	5 (15%)	14 (23%)	11 (19%)
	Village mutual fund	0 (0%)	1 (4%)	1 (3%)	0 (0%)	1 (2%)	1 (2%)
	Cooperatives	9 (33%)	13 (50%)	17 (52%)	13 (39%)	26 (43%)	26 (44%)
	Total	27 (100%)	26 (100%)	33 (100%)	33 (100%)	60 (100%)	59 (100%)
Purposes of loan	Build/buy house	8 (30%)	6 (23%)	9 (28%)	14 (41%)	17 (29%)	20 (33%)
	Education	4 (15%)	3 (12%)	5 (16%)	3 (9%)	9 (15%)	6 (10%)
	Health care	0 (0%)	2 (8%)	4 (13%)	5 (15%)	4 (7%)	7 (12%)
	Durable goods	2 (7%)	0 (0%)	3 (9%)	0 (0%)	5 (8%)	0 (0%)
	Daily living expenses	6 (22%)	5 (19%)	8 (25%)	3 (9%)	14 (24%)	8 (13%)
	Agri-business	2 (7%)	3 (12%)	4 (13%)	6 (18%)	6 (10%)	9 (15%)
	Trade-business	8 (30%)	4 (15%)	5 (16%)	2 (6%)	13 (22%)	6 (10%)
	Others	1 (4%)	3 (12%)	3 (9%)	6 (18%)	4 (7%)	9 (15%)
	Total	27 (100%)	26 (100%)	32 (100%)	34 (100%)	59 (100%)	60 (100%)

* Column total may exceed 100% because of multiple responses for loan source and purposes of loan

of loan money was for building or buying a house for both participant (29%) and non-participant (33%) households. For participant households, meeting daily living expenses (24%), investment in trade/ business (22%), education (15%), and agribusiness (10%) were priority areas where loan money was spent. In case of non-participant households, investment in agribusiness (15%) and 'Other-Social obligations and debt servicing' category (15%), daily expenses (13%), healthcare (12%), and education (10%) comprised priority areas for seeking loans.

It's striking to note that higher number of participant households utilized loan money to meet their daily expenses indicating that projects are targeting the most vulnerable households as beneficiaries. Another noticeable point in the table is that higher number of participant households are utilizing loans in investment in trade and businesses thereby enhancing their capacity to generate income in future.

5.1.5 Social Capital (Access to and Participation in Social Networks)

The study attempted to understand the family genealogy, membership in different organizations, and the networks respondents maintained in diverse fields (government offices, academic circles, healthcare/hospitals and business enterprises). The findings on above parameters are presented in Table 8.

Slightly over a third of respondents were able to provide positive response on family genealogy with majority responding negatively (Table 8). There was a marked difference in response between participant and non-participant groups, with participant group having significantly higher positive response ($p<0.01$) in case of RLRFC, whereas the same was not true in case of JSA. Respondents have membership in multiple organizations as evidenced from the Table 8, and there is a similar trend in membership between the two case studies. Membership in cooperatives, Community Forest User Group, mother's group and Tole Development Committee is quite common. Whereas membership in Water Management Committee is not common, with <10% of respondents being the members. The difference in membership amongst different organizations for participant group and non-participant group is statistically significant ($p<0.05$) for cooperatives and highly significant for mother's group of JSA sample households.

Analysis of the connections the respondents maintained across different organizations (local government offices, academic institutions, hospitals

Table 8: Number of responding households about family genealogy and participation on different social networks, 2019

Description/Membership		RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Family genealogy	Yes	25 (42%)	10 (17%)	21 (35%)	20 (33%)	46 (38%)	30 (25%)
	No	32 (53%)	40 (66%)	34 (57%)	36 (60%)	66 (55%)	76 (63%)
	Don't know	3 (5%)	10 (17%)	5 (8%)	4 (7%)	8 (7%)	14 (12%)
Cooperative	Yes	48 (80%)	42 (70%)	47 (78%)	36 (60%)	95 (79%)	78 (65%)
Mother group	Yes	27 (45%)	34 (56.7%)	49 (82%)	32 (53%)	76 (63%)	66 (55%)
Tole development committee	Yes	34 (56.7%)	33 (55%)	46 (77%)	47 (78%)	80 (67%)	80 (67%)
Community Forest User Group (CFUG)	Yes	48 (80%)	48 (80%)	53 (88%)	48 (80%)	101 (84%)	96 (80%)
Water management committee	Yes	5 (8.3%)	4 (6.7%)	4 (7%)	2 (3%)	9 (8%)	6 (5%)

and business enterprises) in a society revealed that in general participant households as compared to non-participant households have slightly higher number of average connections/network members as well as higher number of reporting households. The number suggest that participant households are better connected, but the difference in average number of relatives/friends working in different organizations for participant group and non-participant groups is statistically non-significant ($p>0.05$).

5.2 Livelihood Strategy (Participant Versus Non-participant Household)

5.2.1 Number of Household Owning Family Business

While analysing livelihood strategy as poverty reduction tool at household level, the focus of attention has been the shift from farming to non-farming enterprises/businesses, assets, debts and income generated thereof, and number of persons employed in businesses owned by participant households versus non-participant households. In case of RLRFC, 53% participant households reported owning household businesses while that number was limited to 28% for non-participant households, and the difference in ownership of businesses between groups is statistically highly significant ($p<0.01$), indicating that participant households are almost twice as likely to own business as compared to non-participant households. Similar analysis for JSA revealed that 42% participant households against 38% non-participant households owned businesses, but the difference was statistically non-significant ($p=0.709$). In both the case studies, it's important to note that 19-36% (n=3/16 and 8/22) of these reporting households own second businesses indicating diversification of income sources (Table 9).

The average value of first business owned by participant households (n=32 and n=22) is worth NPR 2,444,000 (USD 19,869) and NPR 2,308,000 (USD 18,764) for RLRFC and JSA households, which represent 3.5 and 2.7 times more than the business owned by non-participant households respectively. The value of second business, though owned by fewer households (n=8 and n=8), is much larger (NPR 6,024,000 and NPR 3,662,000) worth 8.6 and 4.4 times the business owned by non-participant households. Since the value of business, debts and income did not follow normal distribution, we performed data transformation (log10 for left skewed data) and performed t-test as well as analyzed the data using Mann-Witney U test (non-parametric test). In both the cases, the results show that the differences in value of business, debts and income between participant group and non-

Table 9: Average value of business assets, debts and income (NPR in '000), 2019

Description		RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
		NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000
Value of business	First	2444±1571 (32)	689±182 (16)	2308±1091 (22)	848±388 (23)	23889±1024 (54)	783±239 (39)
	Second	6024±4891 (8)	700±300 (3)	3662±2223 (8)	833±599 (8)	4843±2613 (16)	797±434 (11)
	Total	3950±2799 (32)	820±204 (16)	3640±1923 (22)	1138±427 (23)	3824±1821 (54)	1008±264 (39)
Business debt/ loan	First	4058±3202 (6)	705±316 (6)	1195±694 (7)	1764±1376 (7)	2517±1507 (13)	1275±743 (13)
	Second	1406±730 (3)	50±0 (1)	1475±851 (4)	50±0 (1)	1446±533 (7)	50±0 (2)
	Total	4081±3082 (7)	713±313 (6)	1585±621 (9)	1550±1211 (8)	2678±1371 (16)	1191±693 (14)
Income from business	First	400±103 (31)	216±42 (17)	1009±742 (24)	577±229 (23)	666±328 (55)	424±135 (40)
	Second	624±443 (8)	426±242 (3)	1313±665 (9)	147±44 (8)	989±406 (17)	223±76 (11)
	Total	561±200 (31)	291±62 (17)	1441±934 (25)	628±226 (23)	954±431 (56)	485±134 (40)

Note: Figure in the parenthesis indicates the responding HHs

participant group are statistically non-significant.

Respondents reported business debts/loan amounts owed for funds borrowed to either start or expand their business activities. Relatively higher number of households from JSA as compared to RLRFC groups have debts but the average size of debts is larger in latter group. Analysis of annual income from business revealed that businesses owned by participant households and non-participant households generate an average of NPR 400,000 (n=31) and NPR 216,000 (n=17) for RLRFC group respectively. Similar figures for JSA group stands at NPR 1,009,000 (n=24) and NPR 577,000 (n=23) for participant and non-participant households respectively. These figures are considerably larger than the ones reported by RLRFC group members.

5.2.2 Household Labours

In this section labour force data have been presented as farm labour availability and off-farm employment (Figure 9).

- **On-farm and off-farm employment:** Farm labour availability was consistently higher for JSA groups (participant=184, 62%; non-participant=176, 63%) as against RLRFC groups (participant=151, 54%; non-participant=139, 57%), which is plausible because JSA groups are located in hinterland as compared to RLRFC group settlements. On the other hand, the number of migrants (off-farm employment) workers are comparable for participant and non-participant groups in both case study sites, except that the number is slightly on higher side for participant households in RLRFC groups.

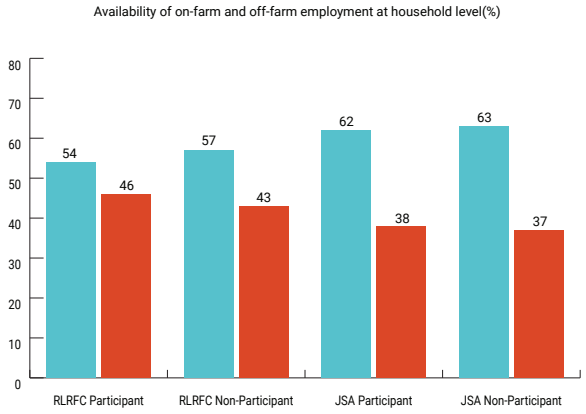

Figure 9: Number of on-farm and off-farm employment at household level, 2019

- **Place of employment:** Place of employment has been categorized into three namely, near to home, foreign country, and in-country but outside the village (Table 10). In case of RLRFC, there is a marked difference in place of employment between participant group and non-participant group, with higher percentage (n=38; 75%) of participant reporting households having their members/workers employed nearer to home, effectively commuting from home thus contributing to agricultural farm labour as well whereas that option is limited (n=15; 27%) in non-participant reporting members. On the other hand, non-participant group households have higher number of households with workforce working in foreign country, as migrant workers (n=30; 55%) and in-country (n=27; 49%), which corroborates the findings of the preceding section, and to some extent also explains fewer connections/social networks within Nepal. For JSA groups, there is a high degree of similarity between participant and non-participant households regarding the place of employment for reporting households.

Table 10: Place of employment for sampled households, 2019

Category	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Near to home	68 (38)	25 (15)	59 (36)	35 (23)	127 (74)	60 (38)
Foreign country	35 (19)	37 (30)	36 (26)	32 (26)	71 (45)	69 (56)
In-country	29 (17)	42 (27)	19 (13)	37 (17)	48 (30)	79 (44)
Total	132 (51)	104 (55)	114 (55)	104 (48)	246 (106)	208 (103)

Note: Figure in parenthesis is the number of responding households

5.3 Livelihood Outcomes (Participant Versus Non-participant Household)

5.3.1 Household Income in 2018

Households employ diverse livelihood strategy to utilize different capitals/assets (natural, physical, human, financial, and social) at their disposal to transform into favourable livelihood outcomes primarily reflected in increased household income, which the study has attempted to capture in monetary terms, as presented in Table 11. As a livelihood diversification strategy, household members not only engage in on-farm activities but they also engage in off-farm activities such as micro-businesses, services, wage labouring, and overseas (migrant workers) employment. Hence, while calculating cumulative household income portfolio, we have added incomes derived from services or wages, remittances, income from businesses, and income from livestock in addition to income from agriculture, government support, pensions/social security disbursements, and return from investments (Table 11).

Table 11. Average income (NPR in '000) of household in 2018

Sources of income	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
	NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000
Income from off-farm	615±147 (46)	365±50 (35)	837±541 (43)	515±72 (30)	723±271 (89)	435±44 (65)
Remittance	1614±366 (19)	734±152 (29)	2050±1284 (23)	537±78 (22)	1853±716 (42)	650±93 (51)
Business income	561±200 (31)	291±62 (17)	1441±934 (25)	628±226 (23)	954±431 (56)	485±134 (40)
Livestock income	43±5 (39)	39±8 (47)	98±21 (47)	55±8 (37)	73±12 (86)	46±6 (84)
Livestock product income	65±14 (21)	18±4 (27)	56±21 (26)	19±4 (12)	61±13 (47)	19±3 (39)
Grain crops	31±8 (15)	13±2 (26)	60±38 (32)	12±3 (19)	51±27 (47)	13±2 (45)
Cash crops	10±3 (16)	15±3 (21)	30±11 (24)	5±1 (16)	22±7 (40)	11±2 (37)
Orchard income	4±1 (13)	11±2 (23)	10±3 (15)	8±3 (12)	8±2 (28)	10±2 (35)
Fishery	169±61 (6)	150± (1)	53±23 (8)	0±0 (0)	103±32 (14)	150±0 (1)
NTFP	± (0)	± (0)	20± (1)	6±0 (1)	20±0 (1)	6±0 (1)
Honey & bee hives	11±4 (9)	10±2 (10)	11±4 (8)	16±5 (7)	11±3 (17)	13±3 (17)
Other agriculture income	25±8 (8)	15±6 (7)	18±3 (10)	13±3 (11)	21±4 (18)	14±3 (18)
Government assistance	146±50 (8)	121±59 (6)	141±41 (16)	178±44 (10)	143±32 (24)	157±35 (16)
Land lease and sale	529±229 (17)	11±6 (3)	75±22 (4)	554±488 (5)	443±189 (21)	351±308 (8)
Gift or money given by relatives	25±6 (8)	11.55±3.32 (11)	39±26 (7)	29±14 (4)	32±13 (15)	16±5 (15)
Pension/senior citizen allowance	161±46 (20)	69±19 (19)	136±28 (19)	46±11 (23)	149±27 (39)	57±11 (42)
Allowance for disabled people	19± (1)	14±4 (3)	± (0)	30±6 (2)	19±0 (1)	21±5 (5)
Insurance	179±179 (2)	32±18 (6)	26±8 (3)	45±26 (4)	88±68 (5)	38±15 (10)
Lottery	± (0)	6± (1)	± (0)	± (0)	0±0 (0)	6±0 (1)
Investment	28±4 (51)	10±2 (31)	14±3 (33)	6±1 (21)	23±3 (84)	9±2 (52)
Others	96±55 (4)	54±41 (7)	153±91 (6)	122±97 (7)	130±57 (10)	88±52 (14)
Total	1621±282 (60)	764±102 (60)	2262±916 (60)	861±124 (60)	1942±478 (120)	813±81 (120)

Note: Figure in the parenthesis indicates the responding HHs

In Table 11, a total of 20 different headings plus a broad heading called 'Others' have been used to categorize sources of income at household level. Of these income sources, eight are directly linked to agriculture, fishery and livestock. Important sources of income include: remittance, services and businesses; social security funds disbursed by the government (pensions, government assistance, senior citizen allowances and disability allowance); few are related to income from land sale/lease, gifts from relatives; and still other sources include insurance payment and return from investments made in businesses. The cumulative household average income for participant households (RLRFC=NPR 1,621,000 and JSA=NPR 2,262,000) is larger by 2.1 to 2.6 times than non-participant households (RLRFC=NPR 764,000 and JSA=NPR 861,000), with remittance, business income and off-farm income as main contributors. For both participant and non-participant households, the average income of JSA group is higher than the income of RLRFC group.

Consistent across the case studies, further analysis of the income sources reveal that considerable number of households earn income from agriculture and livestock, but the amount is miniscule, which suggests the production is still subsistence-oriented with households selling the surplus or forced sell for income. Though practiced by limited number of households, income from fishery is significant for RLRFC group members (Table 11). An additional point to note is the widespread practice, applicable to both the case studies, of investing in shares or investing in businesses as livelihood diversification strategy for the perpetual income derived therefrom.

5.3.2 Household Expenditure in 2018

As a logical step, after analysis of household income sources and the amount, we analyzed household expenditure portfolio. A total of 14 headings plus one 'Other' category was used to apportion the household expenditure (Table 12). It's important to note at the onset that average household income (Table 11) exceeds the expenditure ranging from 1.4 to 3.2 times across different groups indicating that households have savings from their income. This also indicates that households in general are well-off and less likely to fall into debt or poverty trap. However, we did not specifically ask respondents for the household savings in the questionnaire.

Amongst the household expenditure lines, some are basic necessities such as food/drinking water, health, clothing, energy, education, transportation, and communication whereas other expenditures can be classified as comfy expenses such as alcohol and tobacco, hotel and restaurant, and social activities. Still other expenses are in fact investments yielding returns to perpetuity viz. investment in company and cooperative shares, and inputs used for agricultural production. Household expenditure analysis indicates that households accord high priority to educating their children, thus reflected by high expenditure on education in participant (RLRFC=22%, JSA=18%) and non-participant (RLRFC=17%, JSA=21%) groups, and the difference in expenditure is statistically highly significant ($p<0.01$) for RLRFC respondents but non-significant ($p>0.05$) for JSA participants. Expenditure on healthcare comprise a significant component for participant (n=57; 19%) and non-participant (n=57; 12%) households from JSA but not for RLRFC households.

Comparative analysis of expenditure line items between participant group versus non-participant group suggest the pattern statistically significantly differ ($p<0.05$) for social activities, communication, cooking energy and alcohol/tobacco for RLRFC. However, the overall expenditure pattern for two groups do not differ significantly. Though concrete figure on saving cannot be quoted, it can be safely said that HHs (32-43%) are investing for future return in businesses (Table 12). There is one intriguing case to note where participant HHs from both the study sites spend considerable amount in furniture (RLRFC=19 HHs, 28%; JSA=36 HHs, 33%), which could be linked to building of new house, furnishing, and refurbishment drive in the area. Considerable expenditure on 'Other' category was noticed across groups except for participant households in JSA. Closer analysis reveal that house construction and expenses related to organizing wedding comprised the major events that inflated the expenses in this category.

Table 12: Average expenditure (NPR in '000) of households in 2018

Expenditure headings	RLEFC (n=120)		JSA (n=120)		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
	NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000	NPR in '000
Education	213±39 (49)	82±11 (52)	127±34 (44)	126±22 (48)	172±27 (93)	104±12 (100)
Health	51±5 (55)	51±8 (57)	135±70 (57)	72±22 (57)	95±36 (112)	62±12 (114)
Social activities	41±6 (58)	23±3 (59)	24±2 (57)	20±4 (59)	33±4 (115)	22±3 (118)
Agriculture production	23±3 (54)	19±2 (59)	42±11 (60)	28±3 (57)	34±6 (114)	24±2 (116)
Transportation	23±3 (60)	17±2 (59)	25±3 (59)	22±3 (59)	25±3 (119)	20±2 (118)
Communication	20±2 (60)	10±1 (60)	19±2 (60)	18±2 (60)	20±2 (120)	14±2 (120)
Cooking Energy	19±3 (60)	8±1 (59)	12±1 (60)	9±2 (60)	16±2 (120)	9±1 (119)
Food & water	66±8 (60)	60±7 (59)	56±6 (56)	63±7 (58)	62±5 (116)	62±5 (117)
Alcohol/tobacco	25±5 (34)	12±2 (28)	33±6 (32)	35±6 (31)	29±4 (66)	25±4 (59)
Clothing	23±2 (55)	16±2 (60)	26±3 (59)	18±1 (58)	25±2 (114)	17±1 (118)
Furniture	272±185 (19)	49±16 (29)	230±100 (36)	30±7 (25)	245±91 (55)	41±10 (54)
Lottery	0.49±0.26 (7)	24±23 (2)	1±0.8 (6)	0.1±0.03 (3)	1±0.4 (13)	10±10 (5)
Restaurant/ accommodation	49±34 (17)	12±6 (9)	14±3 (20)	9±1 (20)	31±16 (37)	11±2 (29)
Investment	417±283 (19)	50±29 (23)	181±109 (26)	314±142 (19)	281±135 (45)	170±69 (42)
Others	1593±1344 (11)	762±446 (12)	153±61 (14)	456±165 (16)	787±595 (25)	588±210 (28)
Total	974±276 (60)	478±98 (60)	699±109 (60)	601±70 (60)	837±148 (120)	540±61 (120)

Note: Figure in the parenthesis indicates the responding HHs

5.3.3 Energy Use for Cooking in 2013 and 2018

Use of clean energy for cooking is an important indicator of development. In a more traditional rural society, households primarily rely on firewood and biogas as energy source for cooking. But, in a modern society, households shift to electricity and LPG as primary source of energy for cooking. Hence, the questionnaire elicited relevant information on energy use for cooking and how the energy use has shifted in the last five years, and the underlying reasons for the shift. In Table 13 and the ensuing narratives we present the comparative analysis of energy use for cooking between participant and non-participant households for two case studies for the year 2018 only. It's obvious that households utilize multiple energy sources for cooking, so energy type predominantly used by households for cooking has been termed 'Primary Energy' and the second option is termed 'Secondary Energy', and the 'Supplementary Energy' refers to energy type used as fall back system, and used sparingly.

Comparative analysis of energy use for cooking reveal that out of six different options, only three namely LPG, firewood, and biogas are important as primary source applicable for participant and non-participant households in both the study sites, however, the number of households (proportion) using these sources differ (Table 13). The use of LPG as primary energy source for participant households (RLRFC=60%; JSA=30%) is comparatively higher than non-participant households (RLRFC=13%, JSA=23%), with major difference observed in RLRFC groups. In case of RLRFC groups, we observe a major shift from firewood (n=32; 53% to n=14; 23%) to LPG (n=14; 23% to n=36; 60%) between the period 2013 to 2018. Similar conclusion can be drawn for participant households from JSA group as well but with less dramatic results. When we analyse the similar data for non-participant households, no major shift can be observed rather a more gradual

Table 13: Type of energy used for cooking by responding households in 2018

Cooking Purpose	Types	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
		Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Primary Energy	Electricity	1 (2)	1 (2)	-	-	1 (1)	1 (1)
	LPG	36 (60)	8 (13)	18 (30)	14 (23)	54 (45)	22 (18)
	Natural gas	-	-	-	-	-	-
	Coal	-	-	-	1 (2)	-	1 (1)
	Firewood	14 (23)	45 (75)	33 (55)	45 (75)	47 (39)	90 (75)
	Bio-gas	9 (15)	6 (10)	9 (15)	-	18 (15)	6 (5)
Total		60 (100)	60 (100)	60 (100)	60 (100)	120 (100)	120 (100)
Secondary Energy	Electricity	4 (8)	1 (2)	4 (7)	3 (5)	8 (7)	4 (4)
	LPG	17 (35)	41 (76)	32 (53)	36 (66)	49 (42)	77 (71)
	Natural gas	-	-	-	-	-	-
	Coal	-	-	-	2 (4)	-	2 (2)
	Firewood	25 (51)	9 (17)	21 (35)	11 (20)	46 (40)	20 (18)
	Bio-gas	10 (20)	2 (4)	3 (5)	3 (5)	13 (11)	5 (5)
	Others	-	1 (2)	-	-	-	1 (1)
Total		49 (100)	54 (100)	60 (100)	55 (100)	116 (100)	109 (100)
Supplement Energy	Electricity	13 (35)	7 (39)	13 (46)	7 (50)	26 (40)	14 (44)
	LPG	5 (14)	5 (28)	8 (29)	6 (43)	13 (20)	11 (34)
	Natural gas	1 (3)	-	-	-	1 (2)	-
	Coal	1 (3)	3 (17)	-	-	1 (2)	3 (9)
	Firewood	10 (27)	2 (11)	1 (4)	1 (7)	11 (17)	3 (9)
	Bio-gas	7 (19)	1 (6)	6 (21)	-	13 (20)	1 (3)
	Total	37 (100)	18 (100)	28 (100)	14 (100)	65 (100)	32 (100)

Note: Figure in the parenthesis indicates the percentage of the responding HHs in each category

movement from firewood to LPG and biogas is obvious. Use of electricity as supplementary energy for cooking is gaining momentum in both the groups with passage of time.

Respondents from both participant and non-participant groups have given very similar answers when asked about the reasons for shifting in use of energy for cooking. Overwhelming majority have said the shift was prompted by 'more convenient' to use, especially applicable for LPG followed by biogas and electricity. Other important reason for shift in cooking energy use include 'less pollution' while using LPG, biogas and electricity, which was prominently reported in RLRFC (participants=8, non-participants=7) case whereas this reason was rather oblivious in case of JSA households (participants=4), especially amongst non-participant households (n=1). Of course, some respondents have indicated 'increase household income' that made the shift affordable. Some respondents have also cited favourable government policy (subsidy on LPG cylinder) as reason for shift in cooking energy use.

5.3.4 Agricultural Production/ Biodiversity in 2018

Agriculture in Nepal is predominantly subsistence-oriented and the practice is no different in the study area. As a salient feature of the subsistence agriculture, farming practice is highly integrated where crops, horticulture, livestock and forestry play interdependent and reinforcing role in sustaining the

production and productivity of the system. In the process, maintaining species and varietal diversity at household level is considered a cornerstone of resilient agriculture, and adaptation to the negative impacts of climate change. Hence, the study elicited relevant information on crops and varieties maintained on-farm, area allocated to different crop varieties and total production and productivity realized by the households. However, in the following Table 14, we present the comparative status of crop/varietal diversity and productivity figures for the two case studies.

It's obvious from the Table 14 that farmers grow multiple crops in their farm. Amongst the crops, vegetables is almost grown by all households (RLRFC=116, 97% and JSA=113, 94%) followed by rice (RLRFC=104, 87% and JSA=98, 82%) and corn (RLRFC=97, 81% and JSA=101, 84%). As expected, the varietal diversity between the groups and study sites do not vary much because the study sites lie within similar agro-ecological region (mid hills). Across different crops we have observed that not much diversity exist, with exception being vegetables (8 species/HH), spices (4 species/HH), fruits (3 species/HH) and rice (3 varieties/HH). Analysis of productivity figures for different crops between case study sites reveal that for most of the crops the productivity figures are comparable whereas for following crops considerable difference in productivity figure was noticed: corn (RLRFC=1.7 t/ha vs JSA=2.8 t/ha), potato (RLRFC=11.4 t/ha vs JSA=7.4 t/ha), vegetables (RLRFC=14.2 t/ha vs JSA=20.9 t/ha) and beans (RLRFC=5.6 t/ha vs JSA=2.0 t//ha).

5.3.5 Food Intake in Past 7 Days

Respondents were asked based on recall method to fill in the type of food items their family members have consumed for the immediate past seven days. The food items described in the Table 15 closely corresponds to the Minimum Dietary Diversity for Women (MDD-W) prescribed by FAO & FHI 360 (2016). In a rural traditional society, people used to consume two main meals (morning and evening)

Table 14: Crop varieties and their productivity by households, 2018

Crops	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
	Variety (no.)	Productivity (t/ha)	Variety (no.)	Productivity (t/ha)	Variety (no.)	Productivity (t/ha)
Corn	1.07±0.03 (97)	1.66±0.14 (92)	1.21±0.1 (101)	2.84±0.67 (98)	1.15±0.03 (197)	2.27±0.35 (190)
Rice	2.58±0.15 (104)	3.13±0.14 (102)	2.43±0.13 (98)	3.19±0.13 (98)	2.52±0.1 (201)	4.56±0.67 (200)
Wheat	1±0 (2)	0.68±0.25 (2)	1.25±0.25 (4)	1.01±0.15 (4)	1.17±0.17 (6)	0.9±0.13 (6)
Barley	1± (1)	4.8± (1)	-	-	1.0±0.0 (1)	4.8±0.0 (1)
Potato	1.05±0.03 (56)	11.38±1.08 (55)	1.11±0.05 (36)	7.4±1.1 (36)	1.08±0.03 (92)	9.8±0.81 (91)
Soybean	1±0 (7)	0.64±0.21 (7)	1.09±0.09 (11)	1.4±0.65 (11)	1.06±0.06 (18)	1.11±0.41 (18)
Sugarcane	1.2±0.2 (5)	185.19±00 (2)	1.64±0.64 (14)	289.0±121 (12)	1.53±0.47 (19)	274.13±104 (14)
Cassava	3±0.0 (1)	3.41±0.0 (1)	3±0.0. (1)	1.92±. (1)	3.0±0(2)	2.67±0.75 (2)
Mustard	1±0 (36)	0.37±0.07 (35)	1.06±0.06 (33)	0.5±0.2 (33)	1.03±0.03 (69)	0.43±0.1 (68)
Beans	1.84±0.21 (45)	5.56±1.53 (43)	1.69±0.16 (52)	2.01±0.42 (52)	1.76±0.13 (97)	7.79±3.28 (95)
Finger Millet	1.20±0.06 (49)	1.25±0.12 (49)	1.13±0.05 (75)	1.85±0.44 (75)	1.16±0.04 (124)	1.61±0.27 (124)
Vegetables	7.96±0.34 (116)	14.20±1.20 (115)	7.96±0.5 (113)	20.9±6.3 (113)	7.96±0.28 (229)	17.54±3.16 (228)
Spices	4.03±0.17 (90)	6.59±0.77 (89)	3.65±0.21 (79)	9.48±3.8 (79)	3.85±0.13 (169)	7.95±1.83 (168)
Herbs	3.14±0.91 (7)	7.22±2.42 (3)	3.67±1.07 (9)	16.9±6.74 (8)	3.44±0.7 (16)	14.26±5.03 (11)
Fruits	2.37±0.26 (87)	42.69±6.80 (70)	2.7±0.31 (71)	51.0±15.7 (68)	2.67±0.22 (149)	46.78±8.45 (138)
Others	1±0 (7)	10.17±8.64 (6)	1.06±0.06 (16)	18.81±12.2 (16)	1.04±0.04 (23)	16.46±9.09 (22)

Note: Figure in the parenthesis indicates the responding HHs

with one light snacks in the afternoon with no breakfast. However, this practice is changing rapidly, especially in urban and peri-urban settings where light breakfast is increasingly becoming a norm, which can be assumed to be true for the study area. Since we did not directly ask about how many meals households take per day, so to be on the safe side, we assume three meals per day that includes one snack. Therefore, 21 meals in total for seven days can be expected, and the number of times a particular food item has been consumed over the week is presented in Table 15.

Overview of the consumption pattern amongst respondents of RLRFC and JSA reveal that strong similarities prevail. Applicable for both the study sites, among the food items, milk and milk products comprise the most frequently consumed item with 13 times in a week, which has been reported by 80% (RLRFC participants) to 90% (JSA participants) households (Table 15). Other frequently consumed food items include green leafy vegetables, beans/pulses, and other vegetables, which are consumed 7-9, 9-10 and 8-10 times, reported by 97-100%, 95-98% and 78-88% households respectively per week. Animal source of proteins including fish and eggs, which is less frequently consumed by fewer households, nevertheless, the frequency of consumption is still appreciable with 2-5 times a week for each of these items. Comparison of consumption pattern of different food items between participant and non-participant households reveals that there is no statistically significant difference in consumption patterns except for fish and aquatic items ($p<0.05$) and other fresh vegetables ($p<0.05$) for RLRFC and JSA participant households respectively consuming in higher frequency.

5.3.6 Ecosystem Health

Amongst many interventions by LI-BIRD in Rupa Lake watershed area over the past decades, two interventions stand out: (i) sustainable management of Rupa lake watershed that entailed conservation and restoration of Rupa Lake coupled with commercial fish farming in the lake for positive livelihood outcomes led by RLRFC; and (ii) biodiversity conservation and sustainable utilization of agrobiodiversity, more specifically crop genetic resources on-farm, for positive livelihood outcomes led by JSA. Hence, the study elicited the information on availability of ecosystem services viz. provisioning services, regulating services, supporting services and cultural services as a consequence of sustainable management of Rupa Lake, and sustainable management of biodiversity resources by RLRFC and JSA respectively. Therefore, the

Table 15: Frequency of food items consumed in a week (past 7 days), 2019

Food items	RLRFC (n=120)		JSA (n=120)		Overall (n=240)	
	Participant	Non-participant	Participant	Non-participant	Participant	Non-participant
Mutton/Buff	2.6±0.4 (29)	2.0±0.3 (22)	1.8±0.4 (26)	1.9±0.2 (31)	2.2±0.3 (55)	1.9±0.2 (53)
Chicken	2.8±0.4 (43)	2.7±0.3 (33)	2.5±0.3 (51)	2.6±0.3 (42)	2.6±0.2 (94)	2.6±0.2 (75)
Fish and other aquatic animals	2.5±0.3 (40)	1.2±0.1 (10)	1.8±0.4 (21)	1.7±0.3 (12)	2.2±0.2 (61)	1.5±0.2 (22)
Egg	3.9±0.5 (29)	3.8±0.6 (20)	4.8±0.7 (29)	4.1±0.8 (18)	4.3±0.4 (58)	4.0±0.5 (38)
Bean/pulses	9.0±0.6 (58)	9.9±0.5 (59)	9.3±0.6 (59)	8.5±0.5 (57)	9.2±0.4 (117)	9.2±0.4 (116)
Green leafy vegetable	9.1±0.5 (60)	8.5±0.5 (58)	7.7±0.5 (58)	6.9±0.5 (58)	8.4±0.4 (118)	7.7±0.4 (116)
Other vegetable	9.7±0.6 (52)	10.1±0.6 (47)	9.8±0.6 (53)	7.7±0.7 (49)	9.7±0.4 (105)	8.9±0.5 (96)
Fresh fruit	4.4±0.3 (51)	4.6±0.4 (43)	4.6±0.4 (54)	3.7±0.3 (53)	4.5±0.3 (105)	4.1±0.2 (96)
Milk and dairy product	12.3±0.5 (48)	13.4±0.3 (52)	12.6±0.5 (54)	12.9±0.5 (51)	12.5±0.3 (102)	13.1±0.3 (103)

Note: Figure in the parenthesis indicates the number of responding HHs

ecosystem health related questions was designed separately for RLRFC and JSA to correspond to their specific work and the findings are also presented separately for RLRFC (Table 16) and JSA (Table 17), as combining these two sets of results would be less meaningful.

A total of 19 indicators have been used to gauge respondents' answer in temporal scale (past five years – 2013 versus 2018) in terms of 'increased availability of services', 'same', 'decrease' and 'don't know' between participant and non-participant groups (Table 16). Irrespective of which group the respondent belongs to, there is a clear pattern amongst the respondents that they have observed increased availability of ecosystem services across the board for all indicators except for irrigation water, which has remained 'same' during the time scale because the irrigation facility was built long before the stated timeframe.

Conforming to the previous case, in case of JSA, there is also a clear pattern amongst the respondents where they have observed increased availability of ecosystem services for 13 (77%) and 10 (59%) out of 17 services by participant and non-participant households respectively (Table 17). Amongst the services, increase in recreational activity and agro-ecotourism is discernible by both the group members. Comparative analyses of access to

Table 16: Availability of services from the Rupa lake ecosystem restoration and conservation, 2019

SN	Services	Participant (n=60)				Non-participant (n=60)			
		Increased	Same	Decreased	Don't know	Increased	Same	Decreased	Don't know
1	Irrigation water	16 (27)	32 (53)	2 (3)	10 (17)	15 (25)	29 (49)	13 (22)	2 (3)
2	Water for HH use	36 (61)	12 (20)	6 (10)	5 (9)	25 (42)	21 (35)	12 (20)	2 (3)
3	Fish for HH consumption	49 (83)	8 (14)	-	2 (3)	28 (50)	18 (32)	8 (14)	2 (4)
4	Fish for commercial purpose	44 (77)	7 (12)	2 (4)	4 (7)	29 (59)	11 (22)	3 (6)	6 (12)
5	Fodder/forage	36 (63)	9 (16)	10 (18)	2 (4)	29 (48)	16 (27)	15 (25)	-
6	Firewood	50 (85)	6 (10)	3 (5)	-	46 (77)	11 (18)	3 (5)	
7	Timber/poles	28 (48)	14 (24)	15 (25)	2 (3)	26 (44)	20 (34)	13 (22)	-
8	Medicinal plants	15 (31)	12 (25)	18 (37)	4 (8)	11 (25)	18 (41)	12 (27)	3 (7)
9	Aesthetic plants	25 (56)	13 (29)	3 (7)	4 (9)	16 (42)	14 (37)	3 (8)	5 (13)
10	Helps to control flood/ sedimentation/ siltation	48 (80)	8 (13)	2 (3)	2 (3)	54 (95)	3 (5)	-	-
11	Ground water recharge/ water source protection	24 (49)	15 (31)	7 (14)	3 (6)	18 (37)	10 (20)	16 (33)	5 (10)
12	Water purification	36 (66)	12 (22)	3 (6)	4 (7)	34 (76)	5 (11)	1 (2)	5 (11)
13	Maintain greenery/fresh air	45 (76)	10 (17)	4 (7)	-	42 (79)	7 (13)	3 (6)	1 (2)
14	Habitat for wildlife, birds, fishes, plant, insect	40 (67)	5 (8)	5 (8)	10 (17)	40 (67)	7 (12)	7 (12)	6 (10)
15	Regulating local climate	33 (55)	11 (18)	6 (10)	10 (17)	30 (50)	19 (32)	5 (8)	6 (10)
16	Recreational activities	58 (97)	2 (3)	-	-	40 (78)	6 (12)	1 (2)	4 (8)
17	Lake tourism induced business	59 (98)	1 (2)	-	-	40 (71)	10 (18)	1 (2)	5 (9)
18	Cultural use	36 (61)	15 (25)	6 (10)	2 (3)	25 (44)	19 (33)	13 (23)	-
19	Science/educational use	43 (80)	5 (9)	2 (4)	4 (7)	29 (71)	8 (20)	-	4 (10)

Note: Figure in the parenthesis indicates the percentage of responding HHs in each group

Table 17: Availability of services from the agro-biodiversity/agro-ecosystem conservation, 2019

SN	Services	Participant (n=60)				Non-participant (n=60)			
		Increased	Same	Decreased	Don't know	Increased	Same	Decreased	Don't know
1	Food and nutrition	37 (66)	12 (21)	3 (5)	4 (7)	24 (49)	12 (25)	5 (10)	8 (16)
2	Fodder and forage	39 (65)	10 (17)	8 (13)	3 (5)	33 (57)	10 (17)	11 (19)	4 (7)
3	Firewood	37 (62)	18 (30)	3 (5)	2 (3)	38 (64)	10 (17)	4 (7)	7 (12)
4	Medicinal plant	19 (36)	9 (17)	12 (23)	13 (25)	8 (18)	12 (27)	8 (18)	17 (38)
5	Aromatic plant	19 (36)	9 (17)	12 (23)	13 (25)	8 (18)	12 (27)	8 (18)	17 (38)
6	Genetic resources	38 (73)	5 (10)	6 (12)	3 (6)	11 (29)	9 (24)	7 (18)	11 (29)
7	Habitat (for making house/shed)	35 (61)	16 (28)	3 (5)	3 (5)	28 (55)	13 (26)	4 (8)	6 (12)
8	Pollination for agro production	16 (46)	10 (29)	3 (9)	6 (17)	11 (48)	2 (8)	5 (22)	5 (22)
9	Disease and pest control	33 (65)	5 (10)	4 (8)	9 (18)	22 (49)	5 (11)	6 (13)	12 (27)
10	Soil erosion control	38 (73)	6 (12)	4 (8)	4 (8)	25 (61)	5 (12)	2 (5)	9 (22)
11	Air/water purification	39 (77)	4 (8)	3 (6)	5 (10)	29 (66)	7 (16)	4 (9)	4 (9)
12	Habitat for wildlife	44 (73)	3 (5)	6 (10)	7 (12)	38 (63)	9 (15)	4 (7)	9 (15)
13	Soil maintenance	22 (37)	13 (22)	6 (10)	19 (32)	15 (25)	17 (28)	12 (20)	16 (27)
14	Recreational activity	58 (97)	1 (2)	1 (2)	0 (0)	48 (83)	8 (14)	0 (0)	2 (3)
15	Agro-eco tourism	53 (90)	2 (3)	3 (5)	1 (2)	41 (71)	13 (22)	0 (0)	4 (7)
16	Cultural use	39 (70)	11 (20)	5 (9)	1 (2)	33 (58)	20 (35)	2 (4)	2 (4)
17	Science/education use	37 (76)	7 (14)	0 (0)	5 (10)	28 (76)	2 (5)	1 (3)	6 (16)

Note: Figure in the parenthesis indicates the percentage of responding HHs in each group

various ecosystem services by participant and non-participant households indicate that statistically significant differences occur for following services: access to genetic resources ($p<0.00$); recreational activity ($p<0.05$); and agro-ecotourism ($p<0.00$), with former faring better than their counterparts. The result is in fact a true reflection of development agencies' persistent interventions for the past two decades. Another fascinating aspect to note in above two cases is that the benefits accruing from interventions made on biodiversity conservation and watershed management extend way beyond the immediate benefits realized by the participating communities, indicating that biodiversity conservation and watershed management investments have value beyond the geographic boundaries of the projects.

5.3.7 Perception on Climate Change Impacts

Considerable efforts have gone into raising awareness about vulnerability and risks arising from climate change, and adaptation and mitigation measures to be taken at household and community levels. Hence, questions have been asked to elicit respondents' perception about frequency, intensity, damage and mitigation measures related to climate change impacts. However, it has to be acknowledged that the study site in Kaski district is not classified as highly vulnerable, rather the district is classified as moderately vulnerable, which implies that respondents may not have experienced some of the extreme events mentioned in the questionnaire.

Irrespective of their groups, respondents have similar perceptions regarding the frequency and intensity of extreme events in their locality. Extreme events such as drought, high and low temperatures, incidence of plant disease and insect pests, and invasive plant species have become more frequent and their impact has also intensified over the past five years.

The monetary damage incurred at household level from these extreme events is not considerable. Finally, in terms of mitigation measures practiced by respondents, the measures adopted were few suggesting that they don't have robust combat mechanism, though some measures stand out, i.e. measures adopted against plant disease/ pests, which include application of bio-pesticide, insecticide, fungicide, growing of disease resistant varieties, and shift to new crop/variety, and the second measure against invasive species include herbicide application, increased intercultural operations/weeding, and uprooting and burning invasive plants.

6. ANALYSIS OF CAUSES AND UNDERLYING MECHANISMS FOR THE IMPACT ON LIVELIHOODS

This section analyses causes and underlying mechanisms for the livelihood impacts that can be directly or indirectly attributed to project interventions in the Rupa watershed area resulting in the household and community level livelihood capital/asset enhancement thereby leading to positive livelihood outcomes. For this, the household survey findings (Section 5) need to be viewed in the context of the project initiatives implemented to build resilience (Section 3) - particularly the situation of Rupa watershed prior to the project interventions i.e. mid-1980s (Section 3.2) and situation of Rupa watershed post 2010s (Section 3.4). The community level initiatives of both local people and sponsored projects appear to have played a major role in building foundation and therefore in creating conducive environment for individual household members to plan own livelihood strategy and outcomes. It is, therefore, important to consider both community and household level actions/responses when analyzing the causes and underlying mechanisms for livelihood impacts. In the following sections, we first look at how different livelihood capitals were enhanced at community level, ways in which these capitals were used by individual households for own livelihood strategy and outcomes, and how the household level livelihood outcomes differed for participant and non-participant households and reasons for such difference. Drawing on the information obtained through the process documentation, it uses the DFID's sustainable livelihood framework to analyze enhancement of the Rupa watershed's natural, physical, human, social and financial capitals/ assets. At the second stage, using the household survey results and multiple regression analysis, we attempt to establish the causal-relationship between livelihood capitals, livelihood strategy and livelihood

outcomes and then explain the underlying causes for the discernable differential livelihood impacts between participant and non-participant households.

6.1 Strengthening Livelihood Capital: Basis for Household's Livelihood Strategy and Outcomes

6.1.1 Natural Capital

First and probably the most important cause and underlying mechanism for the livelihood strategy and outcomes is the re-enhancement of the Rupa watershed's natural /environmental capital (e.g. rehabilitation of the watershed's denuded hill slopes, restoration of the natural streams and water catchment areas (streams, ponds, lake, and revival of previously disappeared local crop varieties, wild plants and animal species and conservation of crop genetic resources of selected local crop varieties etc). Section 3.2 describes the situation of Rupa watershed area, especially natural resources (forestland, natural streams, Rupa Lake etc collectively termed as 'common property resources') prior to the project interventions in the mid-1980s, and how the poor management of common property resources within the Rupa watershed area had affected natural/environmental capital and people's livelihoods. Later, Section 3.4 describes how these common property resources, following the project interventions, were rehabilitated and restored with improvements in local environment and livelihood situations. The Rupa watershed area now has dense forest with revival of many previously disappeared wild plants and animals. Under the leadership of JSA, many of the local crop varieties, which prior to the project interventions were at the verge of being extinct, have now been revived, and these crop varieties are increasingly used by local farmers both for household consumption and supply to markets. Likewise, the fish stock in the Rupa Lake (managed under the leadership of RLRFC) and the overall annual production and supply of fish to market was worth USD 154,166 last year thus contributing to household income and employment at local level.

Section 5.3.6 on Ecosystem Health of Rupa Lake amply demonstrated that ecosystem services such as provisioning services, regulating services, supporting services and cultural services have all improved, which could be directly attributed to project interventions over sustained period of time, resulting in improved access to local crop genetic resources, expanded recreational activity and enhanced ecotourism in the area thereby positively impacting livelihood outcomes. Improvement in ecosystem services has been reported by both participant and non-participant households in both case studies thus highlighting the fact that investment in natural/ environmental capital benefits wider community by stimulating local economy (ecotourism, hospitability business, etc).

6.1.2 Physical Capital

Section 2.3.1 informs about the development of basic infrastructure/facilities in the Rupa watershed area, including motor roads and communication networks, schools and branch offices of various government departments, including financial institutions and cooperatives and then goes on to describe how these developments, especially the transport and communications sector, have contributed to increasingly integrate the Rupa watershed area into the broader market economy. Later, as the time progressed, JSA and RLRFC and a few other local organizations constructed their own facilities. For example, with financial assistance from the Swiss ReSource Foundation, JSA has constructed Biodiversity Information Centre having multiple uses: displaying information on local biodiversity; office for JSA executives and staff; organizing meetings and workshops/training; and market outlet for local agricultural products. Similarly, using own income from the production and trading of Rupa lake fish, RLRFC has constructed own facilities for use by staff and executive committee members for office, meetings, training/workshops and for storing and trading harvested lake fish products.

The JSA group – the Sundaridanda Community Development Committee - with own fund and financial support from the Swiss ReSource Foundation constructed a 'View Tower' adjacent

to the BIC building. Tens of thousands of local, national and foreign tourists, students, researchers and academics have been using the facilities. More recently, another JSA group - the Participatory Plant Breeding (PPB) group, in collaboration with the government's Centre for Technical Education and Vocational Training (CTEVT) has established a Training School to produce young agricultural technicians with practical knowledge and at the same time integrate their plant breeding work into the course curriculum. The Unnatishil Women's Group which has been involved in the conservation of wetland bird habitat in the Rupa Lake area, is planning to establish a Wetland Study Centre of the Lake Cluster of Pokhara Valley.

One of the reasons for these local organizations to invest in (and for the projects to support) the construction of these physical structures is that not only do such structure provide space for office, meetings and training/workshops, but also serve symbolic identity and value of the organizations and their members, executives and employees in the community and general public. Investment in enhancing physical capital at community level have demonstrated that they contribute to stimulating local economy (ecotourism, market expansion of local agricultural products, proliferation of hospitality business, generation of local employment, etc.), which might partly explain that participant households' assets have higher economic values than non-participant households.

6.1.3 Human Capital

Building and strengthening human capital on the sustainable management and utilization of Rupa watershed's natural resources has been the major objective of all the six projects implemented to build resilience, and included significant capacity building component and investment. The BTRT project included a range of training and extension programmes, including training/courses on raising tree seedlings in forest nurseries, establishing plantations and their protection, constructing check dams and leveling terraces on hill slopes to control soil erosion and prevent downstream sedimentation. The In-Situ and CBR projects provided training and skills on the conservation and utilization of local crop varieties, plant and tree species, on conserving their genetic resources, on crop breeding, on establishing and managing diversity blocks, on multiplication of seeds of rare climate resilient and nutrient dense crop varieties, and on environment friendly farming practices. The CWM project provided training on wetland management and ways for conserving wetland species such as wild rice, white lotus and wetland birds and setting aside wetland habitat for these wetland species. The other subsequent projects included specific training courses on producing and marketing processed (value added) local agrobiodiversity products and branding such products for marketing.

In addition to the above technical knowledge/ skills, there are three other areas of knowledge/ skills the Rupa watershed people were able to strengthen further over the years. One is the social skills, especially for community leaders to work effectively with people and different interest groups and to collaborate with development partners in the planning and field implementation of project activities by mobilizing local human and institutional resources. The other strengthened knowledge/skills relates to the building on and blending the local knowledge, especially knowledge on conservation of local crop biodiversity and their genetic resources with the scientific knowledge. The work of the Participatory Plant Breeding Group is the case in point here. The third strengthened capacity relates to the local community leaders' knowledge and skills to manage the operation and functioning of their respective organizations (particularly JSA and RLRFC, CFUGs, Mothers/Women's Groups, Community Development Committee etc) and to ensure that the decision making process are participatory, transparent and accountable to their members. Today, the Rupa watershed community has many local individuals with social, technical and organizational management capacities required for sustainable management and utilization of Rupa watershed ecosystems.

6.1.4 Financial Capital

The enhancement of the financial capital within the Rupa watershed area has been another important cause and underlying mechanism for the impact on livelihoods. There are now many formal and informal financing organizations/groups, including RLRFC, JSA and mothers/women's groups, which run their own savings and credit schemes. Unlike the conventional banks and finance companies which offer loans charging high interest rates, require collateral and supporting documents, and involve lengthy, cumbersome procedure, these local finance schemes provide collateral free low interest loans.

The extent to which the community level financial capital has been built over time in the Rupa watershed area is reflected from the action of RLRF, JSA and some other local groups. In RLRFC, the share value is reported to have risen eight hundred percent in 16 years - from NPR 5,000 per share in 2002 to NPR 40,000 in 2019. They now have over NPR 150 million worth of asset, fish stock and cash. Each year, in the general assembly meeting, they provide member households dividends of the annual profit. Four years ago, under the leadership of RLRFC, the RLRFC members decided to establish Rupa Savings and Credit unit/wing with collateral free low interest loans to its members.

Likewise, JSA with the seed money from Swiss ReSource Foundation created, four years ago, a Community-based Biodiversity Management (CBM) Fund to support its 17 member groups and through them to enhance livelihoods of their member households. Each group initially receives NPR 50,000 for a fixed period of time, with low interest rate and without any collateral. The concerned group then uses this money to lend to its member households (approximately NPR 5,000 per household). The loan receiving households should use the money for income generating activities, such as goat farming, bee keeping, vegetable production etc. Some households reported to earn up to NPR 150,000 annually from the initial loan of NPR 5,000. The total financial capital of the CBM Fund is reported to have increased from NPR 635,000 in 2015 to over NPR 1.4 million in 2019. More recently, the fixed-term loan amount to be made available to a member groups at a time has also been increased from NPR 50,000 to NPR 100,000.

Some organizations are using their financial capital to support community development work. For example, RLRFC, Jamun Kuna Mothers Group and the various CFUGs donated money ranging from NPR 10,000 to 50,000, to the Sundaridanda Community Development Group for the construction of the View Tower (Section 6.2.2 and also see Section 6.2.5 below). The Sundaridanda Community Development Group, in turn, provides 25 percent of its annual income generated from the View Tower to local community school for use as scholarships to underprivileged children.

In recent years, because of the rapid proliferation of financial institutions, the Rupa watershed inhabitants have been increasingly using and benefiting from such financial institutions. It is then not so surprising that the household survey results in Section 5.1.4 demonstrate no difference in access to credit between participant and non-participant households. However, there is nevertheless difference in the utilization of loan money where participant households tend to invest in trade and business that generates income and support capital accumulation at household level, while non-participant household tend to invest more on agribusinesses, which normally are more risky undertakings.

6.1.5 Social Capital

The last, but not the least, important cause and underlying mechanism for the impact on livelihoods is the way in which the Rupa watershed's social capital was strengthened. Through long-term association and commitment of LI-BIRD and some development organizations, especially those who supported BTRT and In Situ projects, and the deliberate policy of all six projects to work through local organizations in the planning and field implementation as well as strengthening the capacities of local organizations, especially that of the JSA and RLRFC, seems to have been greatly enhanced. Most social organizations seem to have in place a reasonably robust system

of governance and management with decision-making reported to be fairly participatory and transparent and the executive committee members are accountable to member households of their respective organizations.

As indicated in Section 2.3.5, the approach and policy adopted by all six projects implemented to build resilience was to work with existing local organizations (as was the case with RLRFC, Sundaridanda Community Development Committee and Mothers/Women's Groups) or by forming new organizations/groups such as JSA and CFUGs. Not only did such approach and policy assisted in the mobilization of local human and institutional resources in field implementation of project activities, but it also helped to create a sense of ownership among the local people and organizations. It is because of the presence of such strong (or strengthened) social capital in the form of credible local organizations such as RLRFC and JSA that community level actions and responses were possible to regenerate the Rupa watershed's resources and transform the entire landscape that ultimately contributed in the enhancement of livelihood strategy and outcomes.

Augmentation of social capital for participant households is significantly higher than for non-participant households (Section 5.1.5) because these projects have invested considerable time and resources building capacity of leadership in these organizations to establish and strengthen relationship and networks with relevant government and other institutions. Hence, better social networks in government offices, academic institutions, healthcare and business organizations were reported by participant households as against non-participant households, and these connections and networks facilitated and reinforced enhancement of other livelihood capitals.

6.2 Inter-Linkages and Influence of Livelihood Capitals on Livelihood Strategy and Outcomes

In order to explore the causes of differential impacts on livelihood outcomes of sampled households, as evidenced from preceding sections, we have run the inferential statistical tests 'Multiple Regression Analysis' and 'Multinomial Regression Analysis' for variables with interval/ratio scale and nominal/ordinal scale values respectively. Separate regression models for each of the livelihood outcomes, namely, household income, energy use, agricultural productivity, and food intake as dependent variable has been created, with a host of independent variables (individual traits – gender, age, education, caste/ethnicity, risk-taking; household characteristics – family size, total land, migrant workers; livelihood assets/capitals – natural, physical, human, financial and social; and participation in programmes) as explanatory or possible causal factors.

For understanding the underlying mechanisms for the impacts on livelihoods, the research team analyzed the types of project interventions having the potential to contribute to livelihood outcomes since not all project interventions are directed to enhance beneficiaries' livelihoods. Some of the eminent factors include: empowerment of communities – social mobilization, organization at community level, capacity building; technical training followed by materials support to initiate income generating activities at household level; community-level infrastructure support; exposure/learning visits and technical backstopping support; coordination and networking with relevant agencies and establishing links with markets; longer term engagement with communities, etc. The Table 18 highlights the prominent factors having statistically significant contribution to household income as livelihood outcome. The multiple regression model indicated that out of several factors, six factors namely household's participation in development projects, high risk taking behaviour, land ownership, number of migrant workers from household, access

Table 18: Regression analysis output for livelihood outcome (income) for sample households (n=240)

Independent Parameters (Possible Causal factors)	Mean Value	Standard Deviation	Coefficient (or Effect)	t-value	Significance
Participation	0.5	0.501	0.201	3.068	0.002
High risk taker	0.092	0.289	0.413	3.252	0.001
Total land	0.63	0.524	0.177	3.227	0.001
Migrant workers	2.17	1.3	0.182	6.361	0.000
Loan from banking system	0.22	0.415	0.325	4.469	0.000
Assets (log transformed)	5.58	0.831	0.277	4.691	0.000

to loan from banking system, and household assets (house, plots of land) positively influence income of the household.

The descriptive statistics (Table 18) reveals that 50% of the respondents participated in the development programme, of which, 9.17% were high risk taker, and 22.1% of the participants took the loan from banking system. Furthermore, on an average, each household had approximately 2 migrant workers. The regression analysis result clearly indicates that participant households have higher income than non-participant households, which was expected, given that these projects have invested significant amount of staff time, financial resources over sustained period of time enhancing capacity of participants in knowledge and skills, and providing/supporting resources for income generating activities. Individual traits like risk taking is associated with innovativeness, starting new businesses, migration etc., which ultimately leads to diversification of livelihood options resulting in higher household income. Again, risk taking behaviour can be linked to better access to information and support system, which was possible for participant households that explained their higher risk taking behaviour. Livelihood capitals (land ownership and household assets) obviously have positive relationship with income, which was picked up by the regression model. Though projects did not directly contribute to household capital accumulation, the investment support provided in human and social capital played complementary role in augmenting physical capital amongst participant households. Inflow of remittance money from migrant workers have positive impact on household income, so number of migrant workers positively influence household's livelihood. Finally, the sixth factor to have positive impact on household income is access to formal banking system for loan, implying that these households approach banks to seek loans for investment in businesses/enterprises that generate income.

The second was the multinomial regression analysis (likelihood ratio tests) for livelihood outcome (type of energy used for cooking) having nominal scale against independent variables. The Table 19 presents factors with chi-square value and statistically significance level directly influencing household's choice of energy use for cooking purpose. Similar to first livelihood outcome (income), type of energy use for cooking is also influenced by participation in development projects. This causal-relationship to the outcome is more obvious and expected as well because most of the project interventions have focused on reforestation, conservation education, climate change awareness, conservation agriculture, etc. which motivate households to adopt cleaner form of energy such as LPG, Biogas and electricity for cooking as an alternative to firewood.

Analysis of factors influencing household energy use for cooking reveal that seven factors played statistically significant positive role in the process (Table 19). Among these seven factors, participation in projects have the most profound impact on household's choice of energy use. The underlying reasons for the difference have been explained in preceding paragraph. Other important determining factors include family size, number of employed in household, and social network with government/

Table 19: Multi-nominal Regression analysis output for livelihood outcome (energy use) for sample households (n=240)

Independent Parameters (Causal factors)	Chi-square	Significance
Participation z	27.923	0.000
Family size	12.643	0.005
Total employment	12.073	0.007
Social Capital/Network – Government/Municipality	15.301	0.004
Social Capital/Network – Hospital	9.637	0.047
Social Capital/Network – CFUG	11.713	0.020
Loan from Cooperatives	11.149	0.025

municipalities. Convenient to use LPG has been the driving force to use cleaner form of energy for cooking. Smaller family size with members employed in regular job mean that they require more efficient means of energy for cooking. It's interesting to note that higher social capitals (network with government officials, healthcare experts and membership in community forest user group) positively influence cleaner form of energy use for cooking, and so as the accessing loan from cooperatives.

The diversity and frequency of food intake (livelihood outcome) of sampled households is influenced by six different factors, with two factors (age and caste of respondent) having inverse relationship with food intake (Table 20). Among these factors, total land ownership has the most influence on diversity and frequency of food intake, which makes perfect sense. High risk taking behaviour influenced the diversity and frequency of food intake, and so did the participation of households in projects. It's striking to note that two factors such as age and caste (*Dalits* with 7.9% representation) have negative impact on food intake, which indicate the older age group and *Dalits* consume less diverse/frequent foods as compared to other categories. One lesson to draw from the analysis is that though projects tend to state marginal and disadvantaged groups (*Dalits*, minority, disabled, children, women, old age etc.) as their primary beneficiaries, significant progress has yet to be made to make these groups equally benefit from the project interventions.

The multiple regression model for livelihood outcome (agricultural productivity) with several independent factors/variables did not yield any significant results, which was understandable because the findings section 5.3.4 revealed that the productivity of most of the major crops realized by farmers in the study area was lower than the national average. Moreover, as mentioned earlier, these projects' focus has been restoration of ecosystem services, biodiversity conservation, natural habitat conservation etc. rather than productivity enhancement of agricultural crops. It was logical not to have noticed significant difference in productivity of agricultural crops between participant and non-participant households because no concerted efforts in this direction was made by these projects. Therefore, the multiple regression result table and the narrative section has not been included herein.

Table 20: Regression analysis output for livelihood outcome (food intake) for sample households (n=240)

Independent Parameters (Causal factors)	Mean Value	Standard Deviation	Coefficient (Effect)	t-value	Significance
Participation	0.50	0.501	4.409	2.535	0.012
Age	49.48	13.218	-0.155	- 2.105	0.036
Caste (*Dalit*)	0.079	0.270	-7.377	- 2.310	0.022
Average risk	0.287	0.453	5.17	2.035	0.043
High risk	0.092	0.289	9.917	2.939	0.004
Total land	0.635	0.524	5.656	3.251	0.001

Comparative analysis of factors influencing different livelihood outcomes viz. income, clean energy use for cooking, and diversity/frequency of food intake revealed that different set of factors contributed to different livelihood outcomes, with participation in projects as crosscutting factor, which emphatically points to the fact that households' inclusion in project activities make a significant difference in their ability to generate higher income, use cleaner form of energy for cooking, and consume diverse and nutritious food. Apart from participation in projects, individual risk taking behaviour contributes to all tested livelihood outcomes. Perhaps development projects need to be more attentive of these high risk taking individuals (leader farmers) and utilize them in extension activities at local level. Augmenting natural, physical, financial, and human capitals contributed to economic livelihood outcome (income), whereas family size, social and financial capital augmentation contributed to cleaner energy use for cooking. Finally, natural capital, individual traits (age and caste) including risk taking behaviour determined how well the households are food and nutrition secured in terms of diversity and frequency of food intake.

In general, three key messages emerge from the above analyses. Firstly, ready access to (or availability of) livelihood capitals/assets is critical for sustainable rural livelihoods. Secondly, the livelihood capitals, especially the common property resources (forests, water sources, etc), social and financial institutions (e.g., the presence of local organizations such as JSA, RLRFC, cooperatives. Mothers/ women's groups), physical infrastructure (motor roads, communication networks), and human capabilities (knowledge/skills and leaderships) constitute an integral parts of strengthening rural livelihoods, and therefore, sustainable management, utilization and enhancement of these resources is critical. The third and final message is that an ideal strategy for sustainable rural livelihood outcomes would be one which involves investment of resources in strengthening livelihood capitals/capabilities at both community and household levels, instead of focusing and investing resources on one level and undermining the other.

While the analysis shows an overall positive impact on the livelihoods of Rupa watershed inhabitants, one needs to be mindful of the potential challenges/issues which could undermine the above achievements. For example, as have been explained in Section 3.4.10, it is possible for project interventions to give rise to unintended (undesirable) results, such as the human-wildlife conflicts that have arisen as a result of the rehabilitation of the Rupa watershed. There is also possibility for a new unexpected developments, such as the COVID-19 pandemic, to emerge and exert myriads of pressures on the resilience of ecosystem and local livelihoods. Therefore, it is important for CEL nexus programme to be able to foresee/speculate such challenges that could potentially present implications on ecosystems and livelihood policy actions.

7. POTENTIAL FOR REPLICATION/ UP-SCALING

The study shows that initiatives implemented to build resilience in Rupa watershed of Nepal has had overall positive impacts on the livelihoods of Rupa watershed inhabitants. It should be noted that these initiatives were not designed and implemented with CEL programming concept in mind, but had elements of CEL programme. The study shows that there is potential for up-scaling Rupa watershed experience both within Nepal and beyond.

Rupa watershed is relatively a small watershed within the technical know-how and managerial reach of local organizations and communities. The past interventions were designed and implemented based on local needs and aspirations, and were managed and led by local communities, who shared a common vision and interest i.e. ecosystem restoration and conservation for resilient livelihoods.

The key lessons learned from this study is that for successful replication of Rupa experience, it is important to consider the following factors: (i) selected area/site is not too large, rather should be within the technical know-how and managerial reach of the local communities; (ii) the local communities share a common interest, as in the case of Rupa watershed, as opposed to varied or conflicting interest, which often tends to be case when the intervention area is too large; and (iii) the watershed resources and services it provide are critical for sustaining local livelihoods, and are in a deteriorating conditions.

In the context of Nepal, preliminary assessment shows that there are a number of potential areas/ sites where Rupa watershed model could be further strengthened by integrating CEL programming concept and further tested and refined through the design and implementation of pilot project. The potential sites where such pilot project may be designed and implemented are summarized in Table 21.

The sites located in high hills/mountain region or within the protected areas are not recommended because these sites are sparsely populated and there is little or no human interaction within the site. These sites are more of 'Sites for Special Scientific Interest'. There are a number of potential sites in the mid-hills and lowland Terai regions, with potential for replication. These sites are in deteriorating conditions, but are important for sustaining local livelihoods. Five lakes in Lake Cluster of Pokhara Valley and Indra Sarovar Lake (hydropower reservoir) in Makwanpur district in the mid-hills, and Jagadishpur Lake in Kapilvastu and Ghodaghodi Lake in Kailali districts are promising sites. One site each in the mid-hills and lowland Terai could be further prioritized for the design and implementation of pilot project.

There is also potential for replication/up-scaling Rupa watershed experience in China, especially in provinces that share similar socio-economic and environmental conditions. The implementation of pilot project in Nepal and China will allow exchange of knowledge and experience between two communities and countries to learn from each other. Such an approach is likely to have far reaching impact. For example, the lessons generated by pilot project in Nepal and China could be used as 'Learning and Influencing' tool at the global stage through participation and exchanging information in international events such as UN Climate Summit.

Table 21: Potential areas/sites for up-scaling Rupa watershed experience in Nepal

Potential area/site for replication/up-scaling Rupa watershed experience	Basic information	Initial remarks
High Hills/Mountain region		
Tilicho Lake, Manang district, Gandaki province	One of the 10th Ramsar sites in Nepal. Until recently it was known to be the Ramsar site located in the highest altitude in the world, but has now been surpassed.	Not recommended
Rara Lake, Mugu district, Karnali province	Nepal's largest lake, and one of the 10th Ramsar sites in Nepal. It is part of Nepal's national parks, directly managed by the federal govt's national parks and wildlife department.	Not recommended
Syarpu Lake, East Rukum district, Province 5	Occupies 30 to 40 ha land. Have established Syarpu Tal agricultural cooperatives, involving 70 to 80 households. Use the Tal (lake) to produce fish. The Syarpu Cooperative is interest to replicate RLRFC model and has visited RLRFC in recent time.	Worth considering
Middle Hills Region		
Five other lakes of the Lake Cluster of Pokhara Valley	All five lakes are part of Lake Cluster of Pokhara Valley and is recently designated as one of Nepal's 10th Ramsar sites. All five lakes have formed their own cooperatives.	Worth considering.
Indra Sarovar Lake/reservoir, Makwanpur district, Bagmati province	The largest man made reservoir/lake of Nepal (7 km long), built by Kulekhani Hydro project, very popular tourist place	Worth considering
Panchase Lake, located in the junction of Syangja, Parbat and Kaski district, Gandaki province	A bit further away from the Rupa watershed. It is a non-Ramsar site and involves three districts. The area is crowded by too many development actors and the size of the lake is too small for generating any meaningful economic return	Not recommended
Lowland Terai Region		
Jagadishpur Lake/reservoir, Kapilvastu district, Province 5	225 ha; another manmade lake/reservoir, one of the 10th Ramsar sites in Nepal. Considered to be a paradise for wetland birds; recorded 167 wetland birds, 6 mammal species, 8 aphibians and 18 fish varieties, lies in proximity to the Lumbini - the world heritage site.	Worth considering
Ghodaghodi Lake, Kailali district, Sudurpaschim province	2,563 ha; one of the 10th Ramsar sites. Ghodaghodi, which is a natural fresh water oxbow lake is situated at the base of the Siwaliks – the youngest mountain range of the Himalaya, and is the largest natural Terai (lowland) lake of Nepal. Some 850 ha of cultivated land and the population of around 6,700 lie within the site	Worth considering
Bishazari Lake, Chitwan district, Bagmati province	One of the 10th Ramsar sites, but located inside the Chitwan National Park and controlled/managed by the federal govt's department of national park and wildlife conservation	Not recommended
Koshi Tappu, Sunsari District, Province 1	One of the 10th Ramsar sites in Nepal, but controlled/managed by the federal govt department of national parks and wildlife conservation	Not recommended

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