Tribhuvan University
Institute of Engineering, Central Campus
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# ENERGY INTEGRATED SUSTAINALE RURAL RECONSTRUCTION

Plan for

***DHOKSAN***

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**ABSTRACT**

After the 25th April Gorkha earthquake, most of the rural areasof Nepal within the 31 affected declared districts remain deprived of proper living conditions. The conditions are even severe in the 14 "crisis hit" declared districts. The recovery and reconstruction process has been slow due to various reasons though the effort and concern of the people all around has remained continuous. This report prepared during the Elective Course I of Masters of Science in Energy for Sustainable Social Development (MSESSD) is yet another effort to search and find out a way to reconstruct more resilient and self-reliant rural settlements.The three weeks course conducted in lectures and studio was a group work to formulate energy integrated sustainable rural reconstruction plan. The planning approach used is a combination of synoptic and incremental planning approaches and focuses inDhoksan, a peripheral rural settlement ofKathmandu valley. The 2015 earthquake left almost 90 percent of the houses in Dhoksan demolished, since then people are still living in temporary shelters and thiscoursetakes reconstruction as an opportunity to rebuild a self-sustainable Dhoksan village. The reconstruction planning focuses on the energy sensitive reconstruction of the village and sustainability of the reconstructed village, while it tries to address themajorissueof distress migration from rural to urban areascommonly seen inrural areas all around in Nepal.Which is due to lack of opportunities and facilities that guarantee a decent standard of living. The other objective is to make Dhoksana "tourism hub" through agro-tourism that could attract more economic opportunities based on the nature and culture. The synoptic planning started with overall context study to formulate a Vision and then setting Goals and Objectives was further iterated as the single day fields visit and data collections were conducted. Though the planning lacked sufficient data of Dhoksan, an energy sensitive reconstruction and sustainable self-reliant rural village has been pictured in the planning. It is expected to be useful for the reconstruction authorities, concerned stakeholders and the people from Dhoksan forplanning and designing energy sensitive reconstruction activities.

**ACKNOWLEDGEMENT**

The case study was gestated for numerous times. We take this opportunity to thank Prof. Sudarshan Raj Tiwari for assigning us with this study report and tutoring us throughout our study period. We also would like to express our gratitude to Dr. Pranita Shakya for her guidance and support during the course period. In the course of this study, a lot of people have provided help and support without which this study would not have been complete. So, we would like to give our heartfelt thanks to all those who have helped us directly or indirectly.

We would like to thank our program coordinator Assoc. Prof. Dr. Sushil Bajracharya for making our field visit possible. We would also like to thank Bibeksil Nepali for introducing us about their project on reconstructing **Dhoksan** a model village.

We are thankful to inhabitants of Dhoksan Village for supporting us and providing us with the valuable information. They provided 'the goodies'; they welded a difficult segment; they surface-finished flawlessly our most tiring job; they painted the finished job, they turned the blocks of wood; they taught us the trick of their trade. Our bouquet of thanks also includes to our other friends who would expend themselves to pull, push, shove, lift, try, open, close, start, ideate, and catalyze this endeavors.

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# 1. PROJECT BACKGROUND:

Sustainable rural development is vital to the economic, social and environmental viability of nations. It is essential for poverty eradication since global poverty is overwhelmingly rural. Strategies to deal with rural development should take into consideration the remoteness and potentials in rural areas and provide targeted differentiated approaches.
A healthy and dynamic agricultural sector is an important foundation of rural development generating strong linkages to other economic sectors. There is considerable potential for rural job creation not only in farming, agro processing and rural industry but also in building rural infrastructure, in the sustainable management of natural resources, waste and residues.

Sustainability issues in the villages of Nepal are noticed basically because of two major reasons:

- Migration of village people towards cities, thus emptying the villages.
- Development of village in such a way that they are becoming cities and losing the character of village and practicing the unsustainable development and making cities dependent on imported food and losing the closeness with people and nature.

To address the above issues new development shall contribute to compact villages / settlements by being designed to integrate successfully with the existing settlement. So the response to local character without necessarily repeating adjacent forms and details is needed. This shall include referencing the elements of the area that give character and a sense of place such as urban grain, historic core, buildings of architectural merit and local characteristics (e.g. local materials, building lines, walls, building heights, rivers, streams, trees / hedgerows and other local built/landscape features.
From a development point of view, the objectives of planning have evolved over the years from a focus on increased production, through greater efficiency and effectiveness, to explicit concerns in recent years about equity issues and the reduction of poverty and vulnerability. Human capital development, infrastructure and social development are being woven into integrated rural development strategies.

Our study focuses on the development of village in such a way that they physically remain village preserving the natural resources but still having the services of that of an urban. The major occupation of

a village will remain agriculture, the village will be living close with nature, but energy integrated healthy and active livelihood will be promoted.

## 2. METHODOLOGY

Qualitative research methodology was used for the planning of Dhoksan. Since, the objective of the study is to make a development plan of the existing village of Dhoksan, in such a way that the village remain "village" but "developed", the "living with nature" is maintained, the agriculture productivity is not reduced and healthy and active livelihood is achieved, the study methodology employed was exploratory and descriptive which was based on both literature and observation. Therefore, both qualitative and quantitative approach has been considered in the study. For this the study was distinguished into four characteristics of eco-city and sustainability which are physical, socio-cultural, economical and energy efficiency. For this different analysis parameters such as land use, built form, transportation, open space, water bodies, infrastructure, agriculture, tourism and energy were used. Observation and literature review were used as data collection techniques. Constructivist paradigm was followed. The research was based on field visit and community interaction through interview and a workshop.

Bottom up approach was used. Basic ideas were generated from the rough data from literature and the presentation given by Bibeksil Nepali. The ideas were arranged and interpreted for the initial planning of the village, which was done before the field visit to Dhoksan on the class of Energy Integrated Rural reconstruction. Data for sustainable planning of water, transportation, agriculture, reconstruction and tourism were obtained from literature and related to the context of Dhoksan. Photographs, informal interviews, direct observation were used as tools of data collection during the day of field visit. A workshop was also organized on the day of field visit where locals were invited for interaction on mutual perception regarding the development strategies of the village and a formal interview was conducted on the workshop, which helped us in collecting information that were missing on the field visit.

# 3. VISION AND GOAL SETTING, CORRESPONDING ACTIVITIES

**VISION:**

**'A clean and prosperous village which integrates reliable energy in achieving socio-economic sustainability.'**

| | |
|---|---|
| **Economic sustainability:**<br>a) Enhance nature and culture based economic opportunities for rural livelihood | **Environment sustainability:**<br>b) Healthy ecosystem by conserving natural resources to protect bio-diversity |
| **Social sustainability:**<br>c) Promote quality livelihood by increasing social capital | **Energy:**<br>d) Energy development for managing energy demand |

**Goals and their strategic Objectives and Activities are as follows:**

| | **STRATEGIC OBJECTIVES** | **ACTIVITY:** |
|---|---|---|
| **A) Enhance nature and culture based economic opportunities for rural livelihood** | • Develop infrastructure required for tourism and agriculture<br>• Preserve agricultural land and natural heritage area<br>• Generate capital for enhancing tourism and agriculture<br>• Increase the value of agriculture | • Agricultural land and natural heritage area in land use plan<br>• Agricultural hub<br>• Cycling and trekking trail: stoppage, service area, parking, eateries, toilets<br>• Well planned viewpoint area<br>• Tourist center<br>• Irrigation canals<br>• Micro finance, easy loans |

| | | |
|---|---|---|
| | | • Linkage with Nagarkot, Kathmandu, Sankhu |
| **B) Healthy ecosystem by conserving natural resources to protect bio-diversity** | • Monitor natural resources and biodiversity –land, forest water<br>• Co-beneficial conservation strategies<br>• Promote alternative energy<br>• Reduce natural degradation for energy use<br>• Retain habitable natural conditions for local bio-diversity<br>• Educate people about eco-system<br>• Community based natural resource management<br>Promote resource recovery | • Regulatory activities<br>• Natural heritage in landuse plan<br>• Natural conservation organization<br>• Assessments and workshops<br>• Alternative energy technology<br>• Restrict area and trespassing<br>• Protection of forest watershed, wetlands and other water resources<br>• Community forest<br>• Forest park corridor<br>• Behavior change: separation of waste<br>• Reuse materials like stone and wood in new construction<br>• Promote waste to energy like briquette making, biogas plant<br>• Greywater recycle for kitchen garden |

| | | |
|---|---|---|
| **C) Quality livelihood by increased social capital.** | • Promote social and cultural activity; adherence to good culture<br>• Community capacity building by social mobilization<br>• Provide access to basic services<br>▪ Education<br>▪ Health<br>▪ Water and sanitation<br>▪ Energy<br>• Ensure food and nutrition<br>• Promote Safety and security<br>• Promote participation of local in planning process and its implementation<br>• Provide recreation and community support<br>• Strengthening social institutions<br>Ensure right, equity and justice | • Promote organic food production and storage facility<br>• Formal and vocational training<br>• Easily accessible health service<br>• Health/ Sanitation awareness<br>• Vocational Trainings<br>• Accessible drinking water<br>• Recreation for all age groups |
| **D) Energy development for managing energy demands** | • To promote indigenous renewable technologies<br>• To ensure energy conservation practices<br>• To encourage use of energy efficient technology<br>• To minimize energy demand during reconstruction | • Design a compact settlement plan<br>• Trainings for local people on resilient and safe construction<br>• Assess the distance and embodied energy of building materials<br>• Aware local people about alternatives to cut off dependency on central energy system<br>• Encourage pedestrian through separation of vehicular and pedestrian road in spatial planning.<br>• Promote gravity flow for distribution |

| | | |
|---|---|---|
| | • To aware people about the passive, vernacular buildings<br>• To develop trust on local building materials<br>• To revise the indigenous construction technologies | of water supply system<br>• Incorporate rain water harvesting in housing design<br>• To promote bio-degradable materials like compact earth, CSCB in reconstruction<br>• To introduce energy efficient cooking devices like ICS<br>• To encourage use of energy efficient appliances and fixtures.<br>• To establish RET's like micro hydro power for electricity.<br>• To preserve and improve the existing traditional water mill |

## 4. SITE STUDY AND RESETTING GOALS

From the comparative analysis of the field scenario and the preset goals, no much interventions were made on the overall goal however many new issues were discovered thus the objectives and activities were adapted as per the need.

Availability of water was very limited in the Dhoksan Village. The conservation of natural resources like forest were addressed in concern to the protection of the bio-diversity however after the field visit the need for the afforestation was much prior for the conservation of the water bodies. The nature sources were discovered to be drying up. Thus protection and enhancement of the water bodies are one of the major focus. In fact several activities such as construction of the swales and reservoir etc. has been incorporated in order to address the issue. Even more with this level of scarcity no hydropower plant would be possible for the place. In other hand large quantity of the fuel wood are being consumed at the village for the production of wine hence the

promotion and provision of the cleaner renewable is highly desired for the environmental sustainability

Similarly with the need of economic development, the cultural aspect has been slightly over shadowed and now people are rather aligning towards the activities that gives more money thus culture based economy such as tourism has been well focused. Activities such as volunteering works, scaling up the local skills such as handicrafts, culinary etc. has been included. The need for the creative income generating opportunities for the women and their empowerment has been addressed. In other hand activities such as mushroom cultivation, organic vegetable farming has been introduced boast the economic status. Similarly from the field study, the livestock cultivation was found to be in considerable number in most of the household thus the sources for the provision of their food is addressed in the planning.

# 5. INTRODUCTION TO DHOKSAN

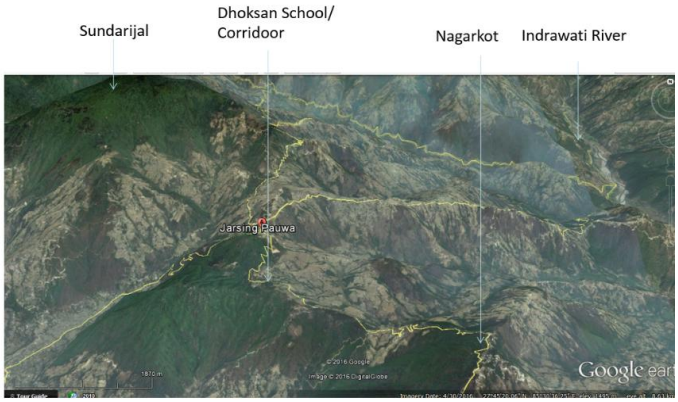



*Figure 1: Topography view of Dhoksan*

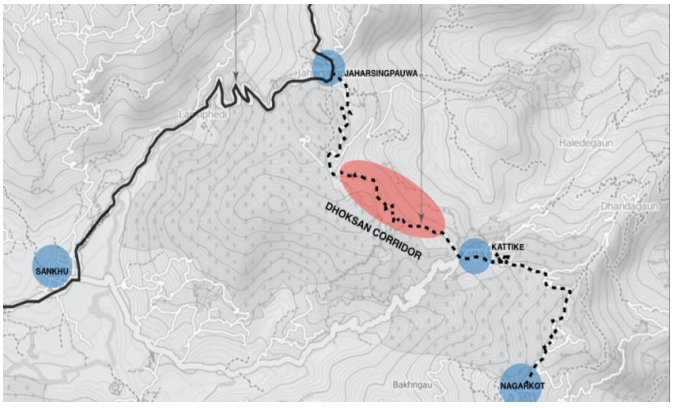



*Figure 2: Sankhu to Dhoksan*

Dhoksan is a beautiful village close to Kathmandu, connecting Chisapani and Nagarkot, but still is not a tourist destination. It is located at an altitude of 1810m. This village lies in Shankarapur municipality-5, approximately twenty five kilometers from Chabahil. Shankarapur is surrounded by Sindhupalchowk, Kavre and Bhaktapur district. The area is basically an elevated tar land with sloping terrain towards the Khodku and Godavari River. Jarsingpauwa is the closest market for the people living in Dhoksan. This village is also known as *sano Nagarkot*. Dhoksan is a trekking and biking corridor connecting Nagarkot to Chisapani.

There were around 145 houses in the village before the devastating earthquake of Baishak, 2073 which damaged almost 90 percent of the houses. This made the people to live in small temporary shelters.

From the houses that are still standing we got to know that most of the old houses are made up of stones and unburnt brick wall, clay plaster, wood frame and slate roof. But most of the houses roof was replaced by CGI sheets because of the unavailability of slates. There are also few RCC houses coming up.

*Fig 2 :*

The total population of village is 740. They are involved in agriculture for their livelihood but some most of the women even produce wine for generating income. Corn, rice, millet, beans, mustard, potato, vegetables etc. are the major crops grown. Dhoksan at the present state lacks adequate supply of water and the agriculture totally depends on the seasonal rain. Therefore, corn farming is extensively done because it requires less irrigation. The major reason that hindered the village's development is migration of youth towards the city and abroad for job.

The majority of people in Dhoksan are Tamang. They have their own culture and language. Institutions like *Nhangkhor* play active roles in conducting the socio-cultural activities of the community. The major festivals celebrated by the Tamangs are Buddha Jayanti, also known as Saga dawa in their language, Losar (New Year), Tihar and Dashain. Their favorite musical instrument is the *damphu drum* (tambourine) and *Tamang Selo* is one of the most popular traditional Nepali music. Lhosar not only has cultural and religious significance but also economic, health and social importance. Khapse (sweet made by mixing rice flour with sugar and ghee), Babar (rice flour bread) and Gutugpa (a dish containing nine different ingredients) are some of the major foods prepared in Lhosar. It is celebrated with cultural songs and different types of cultural dances.

*Figure 3: Tamang festivals 1*

# 6. EXISTING LANDUSE & AMENITIES

## 6.1. Existing Land use

### 6.1.1. Forest

Forest covers approximately 50% of proposed total area. Forest is abundant at hilltops above the road. Similarly, trees are dense along the drainage of stormwater. Uttis, Bakaino and Chilaune are indigenous trees of that area. However there is abundance of pines, ferns and rhododendron as well. There are also plenty of bamboos along the valley. Along with trees, there are some other shrubs and ferns. Apart from plants, there are small grazing lands within forest. Forest also provide habitat for different types of wild mushrooms.

### 6.1.2. Maize Field

Maize field is one of the major agricultural products of Dhoksan. People cultivate the maize in between forest areas and paddy fields. These areas get wet only during monsoon season. The taste of the maize is pretty good however the quantity is not as per the land. Dhoksan possesses sandy loam soil. This particular soil is appropriate for maize cultivation. However there are several other influencing factors like nitrogen content for growth, wind for pollination. The wind velocity is comparatively higher in upper areas than in lower areas. Also the sunlight above the hills is not enough. Those could be the probable reasons for good color of corn leaves in lower areas than in upper areas, that was noticed while our field visit.

### 6.1.3. Paddy Field

The paddy fields are near the Ghatte khola , lowland of Dhoksan where field can get irrigated easily through the stormwater and riverwater. It may be because the paddy requires floody land where the water is abundance. Local people have tradition of harvesting the stream water for rice cultivation. Likewise, rice requires 6-8 sunhours for 40 consecutive days from plantation. This implies that the sunlight is also maximum at that place.

### 6.1.4. Settlements

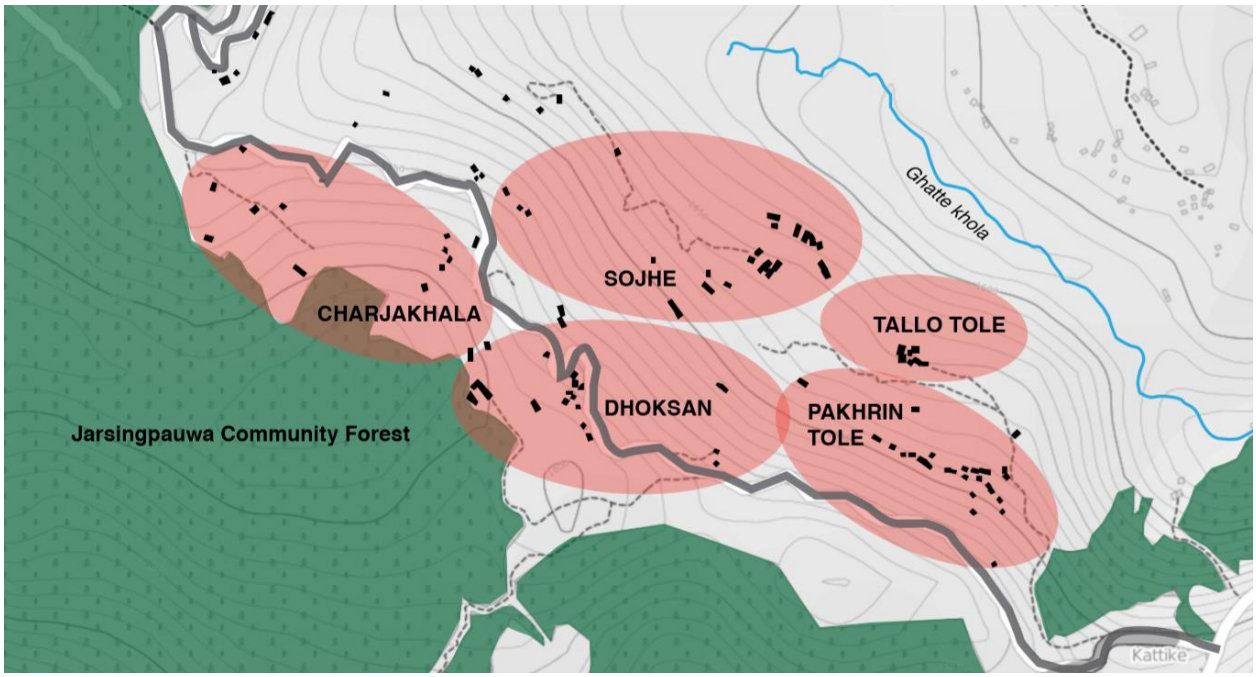



*Figure 4: Settlements of Dhoksan Village*

At present, residential zone in Dhoksan were located either along the road sides or at the hillocks between the road and the river. The clusters of houses make 3 different toles, namely; *Pakhrin tole, Sojhe tole and Talle tole, Dhoksan, Charjakhala.* The location of the settlements was guided by the length of the sunshine it receives and the orientation of the building depends upon the wind.

## 6.2. Existing amenities

*Figure 5: Shiladevi School*

*Figure 6: Agricultural Mill*

*Figure 7: Bhukampa Karkkhana*

### 6.2.1. Gurans Rest Camp

Gurans Rest camp is resort type of infrastructure where there are lodging and fooding facilities. It provides a sense of entry to the visitors at Dhoskan. As per the employee it has not been long

that it was established. There are different building materials used. The initial building units were constructed from RCC structures. On the contrary recently added units are made up of bamboo.

#### 6.2.2. Shiladevi Primary School

Sila Devi primary school is the only school in Dhoksan which provides education up to class 5 to 55 students in total. It is located towards the south-west part of the village at an elevated land near the forest.

#### 6.2.3. Bhukampa Karkhana

It was constructed by Bibeeksheel Nepali for training the people. It has already provided trainings of brick masonry and planning for other skillful trainings like hospitality, hotel management. Also it opens the platform for any kind of skillful trainings. The physical appearance does not resemble the vernacular architecture of Tamang. Instead it was construted out of infill panels and steel structures.

#### 6.2.4. Agricultural Water Mill:

Dhoksan village use the existing water mill across the river line located in the nearby village. But the insufficiency of the flow of river makes it function seasonally. In nepali mill mean “Ghatta” and the stream from which water mill harvest its energy is called “Ghatte khola”. Also it should be noted that the Ghatte khole itself is not the river but a stream which is fed by rainwater of Dhoksan area. Whole Dhoksan area serves as catchment area and Ghatte khola acts as stream.

#### 6.2.5. Kusum Communtiy Forest

Kusum community forest is situated at the hill top. It provide dry fuelwood, fodder to the villagers. Sometimes during monsoon, it allows the villagers to hunt mushroom. It also has a small grazing land for small cattles. There is no requirement of permit fro entry.

# 7. PROPOSED LAND USE PLAN

## 7.1. Forest and its extension

The proposed landuse plan tries to conserve the existing forest at first and then also extend to the roadside. The differentiation of forest zone restricts settlement and extension of agricultural field. Further, it promotes strict regulation against anti-forest activities like burning, collection of firewood etc.

The afforestation program is proposed between Kusum community forest and road. These roads are now used for maize cultivation even when the production is not enough as per effort and time. Indigenous tress will be plant because those trees help retain the water and are good for sloppy hills. Also addition of those trees can increase the habitation of forest ecosystem and wild mushroom.

## 7.2. Maize field

Through categorization of maize field in landuse, the policies can be developed in order to develop the maize field collectively through separate planning. Likewise it also discourages the settlement extension into maize fields. But use of maize field for other crops like mustard, millet or even different cash crops like mushroom shall be encouraged.

## 7.3. Paddy Field

The identification of paddy field in land use clarifies high irrigated zone such that well channeled irrigation can be developed. Also the demarcation of paddy field encourages rainwater and stormwater collection, storage and water for irrigation and other water irrigation techniques. Moreover, these lands claim protection from flood during rainy season.

## 7.4. Residential Zone

Therefore, instead of proposing some newer future settlement, a plan for densification of present residential zone is proposed. The densification of the residences is planned to take place in Sojhe tole, Pakhrin tole and Ialle tole where sun hour is sufficient for residential purpose. The new residences shall developed in between the toles, to connect them and make a huge and dense cluster of settlement.

The main objective of residential zone is to maintain the vernacular architecture of Tamang of Dhoksan. Without major intervention in local character, some modern infrastructures can be developed:

| | |
|---|---|
| Community amenities: | Small retail shops |
| | Stationary shops (photocopy and printing) |
| | Vegetable shops |
| | Environment friendly cottage industries |
| Open spaces: | playgrounds |
| | Social junctions |
| | Small eateries |

Homestay:

## 7.5. Commercial Zone

Commercial zone is not distinct at present. But Dhoksan requires commercial areas for an alternative source of generating income through sales and services. The marketing of its local product will certainly help the area to boom its economy. The proposed landuse plan has distinguished three areas as commercial zone on the basis of present and possible future amenities:

1. **Gurans Rest camp's vicinity:** Dhoksan village does not have sense of entry at present. But one can feel sense welcoming environment as soon as one reach to Gurans Rest Camp. Hence it is proposed that different types of commercial activities shall be encouraged here. Some probable physical facilities at this particular commercial zone are:
    a. Bus park
    b. Tourist information center
    c. Food stalls
    d. Local handicraft market

2. **View deck:** There is no such thing as view deck at present but can be proposed considering beautiful mountain views and vistas full of agricultural fields. It is proposed at the junction of forest pathway and Jarsing pauwa – Nuwakot road.
3. **Agricultural hub cum tourist service center:** Both agricultural hub and tourist service center are proposed as major activities for reconstruction of Dhoksan. The location of these centers is chosen near present residential zone and future densification zone. Commercial activities like trading surplus agricultural products, packaging, loading and unloading the finished products are likely to happen.

## 7.6. Community and Educational Zone

Though there is no any distinct community zone at present but during field visit, certain possibilities were observed to develop a particular place as community zone as there were Old Siladevi Primary School, Running Shiladevi Primary School, Bhukama Karkhana For trainings and workshops. Therefore this zone can be developed as community zone which not only will

provide services to the people but also help in building social capital. Some infrastructures that can possibly expand at this zone in future are as follows:

- School extension upto lower secondary
- Health centers
- Office of community forest user group
- Youth clubs

### 7.7. Clean Industrial Zone

This zone is proposed in order to encourage clean industries which can provide other income generating activities. The location of industrial zone is selected on the basis of energy tapping. It is placed near to water reservoir such that hydro energy can be tapped in order to run machines and equipments of industries. Basically two industries have been proposed:

a) Agricultural mill: To fulfill the current need of the grinding mill and provide a solution to its intermittent use, the new improved water mill is proposed in close proximity to the residential zone. Community Distillery: Since the water reservoir and water channel is nearby, a community distillery is proposed at clean industrial zone.

b) Community alcohol distillery

## 8. WATER RESOURCE MANAGEMENT PLANNING

### 8.1. Natural water system:

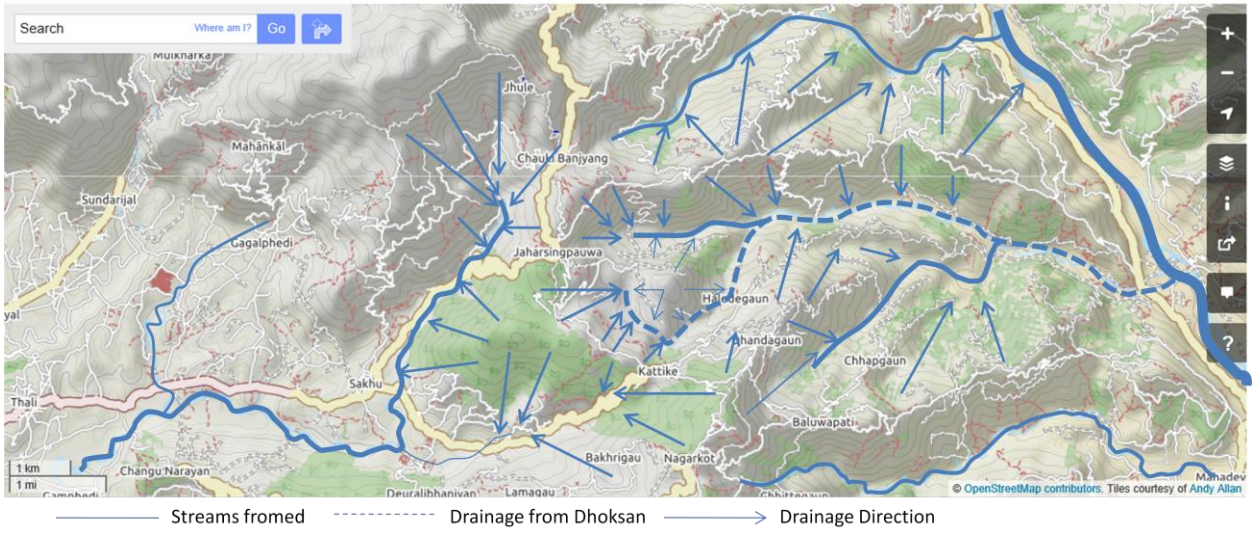



*Figure 8: Natural Hill Drainage System*

**Hills' drainage:**

*Precipitation, inform of rain, in these hills is drained from gullies to meet at lowest contours finally forming into streams from converging drainages. During rain, water percolates through the ground, recharging aquifer; springs waters.*

**Dhoksan Water resources:**

Springs, constructed wells, piped water supply system, from springs, and channelizing gullies are major sources of water.

Water resources in the village of Dhoksan are inadequate for the household requirement at present. Though the hill in which the village is situated is moist and has various spouts, the lack of proper water supply system and water resource management arises many issues regarding water. The changing land uses and their relation to the hydrographical cycle has started to dry the aquifer sooner and thus there is scarcity of drinking water in winter. Lacking proper water supply system has low water efficiency since the water continuously flows at some spouts while the community taps only receive water for few hours a day.

The area receives 2048mm of rainfall annually, out of which 83% falls in monsoon season. The highly contouring topography of the hill with decreasing vegetation couldn't hold the rainwater for long and thus flash flood in the streams are common. Though the practice of flash flood irrigation is used for paddy plantation, there is no reservation infrastructure and no facilities for irrigation.

## 8.2. Water Uses

Water uses in village is basically for household activities and agriculture. Sources for household water present in Dhoksan village are springs, wells, sprouting from aquifers and piped water supply system fed from local springs. Rain water is heavily relied for agriculture purpose. Canals are drawn from gullies to agricultural terraces, capitalizing on height difference. During dry seasons, local aquifers feed waters to the pipelines and constructed wells.

### Water for Household

House hold activities which require waters are for cooking, washing, cleaning, bathing and animal rearing. Piped water supply system plays vital role in fulfilling household water demands. Mostly piped water supply system facilitates near house tap facility. Where pipelines do not reach or when it dries out during dry season, people fetch water from local springs and wells. As

the water runs off to lower terraces, the terraces are cultivated with low water consuming plants. The piped water supply system, at user's end is mostly controlled by tap. However, there is high loss of water, from pipe connections.

### Water for agriculture

Land uses for agriculture in Dhokan can be found for paddy fields, house near farms and rainwater depended farmlands, where canals cannot be drawn in and are in sloped lands and define forest borders. Lower terraces, close to perennial river, *GhatteKhola,* are mostly paddy fields, where irrigation canals are drawn from gullies. Canals are earthen and need to be dug for maintenance during cultivation. Water is drawn turn wise for each farm land. Terraces, which are filled with, water, supply water to lower terraces. Stone baffle is used to avoid soil erosion in water dropping points in terraces. Farmland close to settlement, where water supply is inadequate for paddy cultivation, is reliant on rain water. Water drained from household is channeled to lower land, where mostly leguminous plants, corn, vegetables are grown in these yards and surrounds the built setting.

So the water resource management planning tries to address these issues through following approaches:

## 8.3. Water conservation strategies

The hydrological cycle flowing through the area is considered the clue to solving all water resources related issues. For meeting water demand accordingly to the time of requirement throughout the year could be met by intervening the current hydrological cycle in natural ways to create a cycle that circulates according to requirements. For this the whole hill has been divided into three levels with three different strategic activities.


*Figure 9: Water Conservation Strategies*

**Ridge Level:**

At this level the major strategic activity is to reduce runoff and try to retain rainwater as much as possible to recharge it into the aquifer. Strategic activities are Runoff reduction, Rainwater retention, Recharge increment, Swales and Vegetation.

**Steep Slope Level:**

At this level the rainwater retention is not possible but the runoff can be reduced and recharge can be increased to achieve reliable amount of water in the natural aquifer. The strategic activities are Recharge increment, Agriculture, Vegetation.

**Bottom Level**:At this level the rainwater reservation is possible by creating dams at strategic locations, which can be used for irrigation, fishery and other recreational purposes as well. For this following activities are proposed: Runoff collection, Reservation, Small-scale Irrigation reservoirs, Pools and Watersheds.

**Swales:**

Swales are long, shallow ditches designed to trap water and allow it to soak into the soil, recharging it with moisture. They run along the contour of the land, usually on sloping ground where water would otherwise rush off, leaving the land dry and eroded. A series of swales can be positioned down a slope to distribute the water evenly. In time, trees will shade the swale and add leaf matter to it, improving its water holding capacity. And this is the other great thing about swales, not only are they virtually maintenance-free, but they improve with age. A mature swale system can reduce the water run-off by up to 85 per cent compared to bare soil.

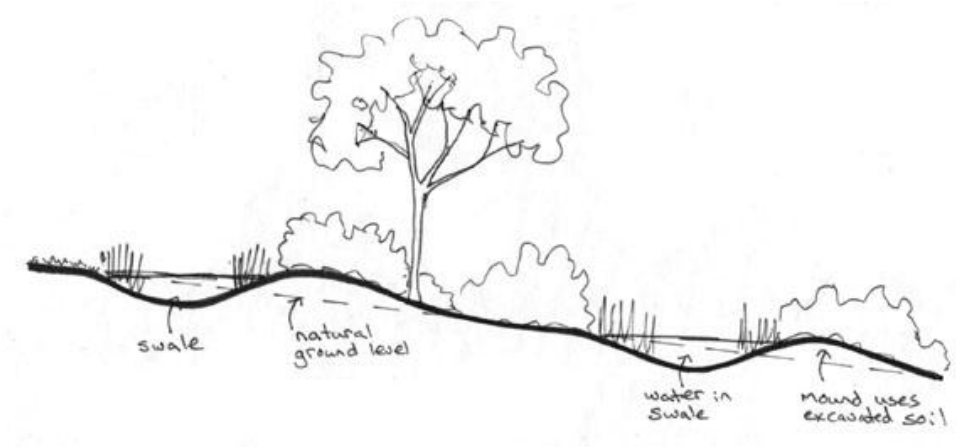



*Figure 10: Swale*

**Runoff Retention Chain:**

The Dhoksan corridor road segment running through the mid range of the hill acts as a possible line where the runoff from above the road can be collected and retained in swales running along the road and small reservoirs at strategic locations. This retention chain could hold water for 2-3 months after monsoon enough to irrigate the vegetable plantation half the area of its catchment.

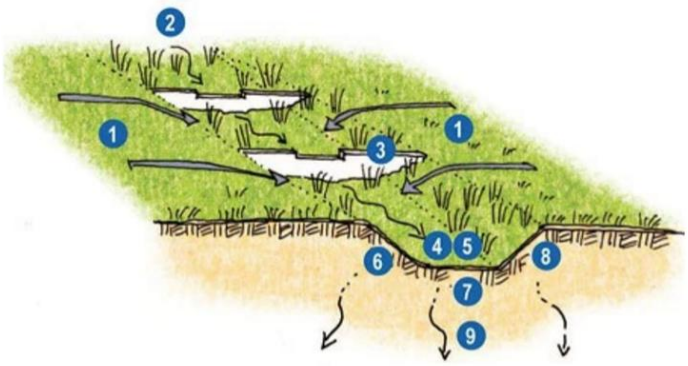



*Figure 11: Runn Off Retention*

**Reservoirs:**

The topographically centralising catchment of the area has many locations where small to medium scale reservoirs can be made. The flash flood reservoirs can be made between Pakhrin and Sojhe to feed vegetable farming done after monsoon. Water efficient irrigation technologies can further increase its effectiveness.

## 8.4. Gravity fed distribution supply

Locating the waterspouts, accessing their capacity is essential first step before designing any water supply system. Since currently the three major settlements are using different spouts for their water demand, decentralized individual water distribution supplies are more preferable. Gravity fed supply chains with reservoirs above these settlements should reduce the potable water loss and avail during dry season.

**Cluster 1:**

No. Of HH: 56 + 25% = 70

Population: 371

At per capita 40-liter/day daily demands: 14480 liters

**Cluster 2:**

No. Of HH: 32 + 25% = 40

Population: 212

At per capita 40-liter/day daily demands: 8480 liters

**Cluster 3:**

No. Of HH: 52 + 25% = 65

Population: 344

At per capita 40-liter/day daily demands: 13780 liters

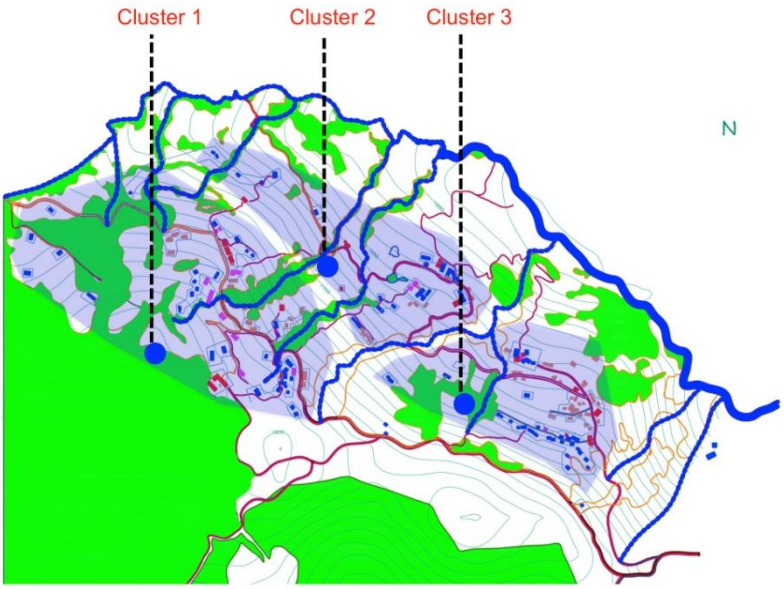



*Figure 12: Water Supply Cluster Plan*

# 9. INFRASTRUCTURE PLAN

## 9.1. Transportation planning

Transportation planning consists of three types of road networks – primary roads will be used for four wheelers which will help in the transportation of people and goods in and out of the village, secondary roads will be used for bike trail and pedestrian while tertiary roads will be used only for pedestrian. The existing road connection Jaharsing Pauwa to Nagarkot is the primary road and this roadway can be black-topped for easy transportation. This road network will help for an easy access of local people to the city and market. The secondary road will be bike and walk friendly which will provide an alternative route to the primary road for bicycle trail and a pedestrian. This road should discourage the use of motorbikes and will be dirt raod. The tertiary road will help the locals to move from one place to another within the village like from home to school, Bhukampa Karkhana, to agriculture field etc.

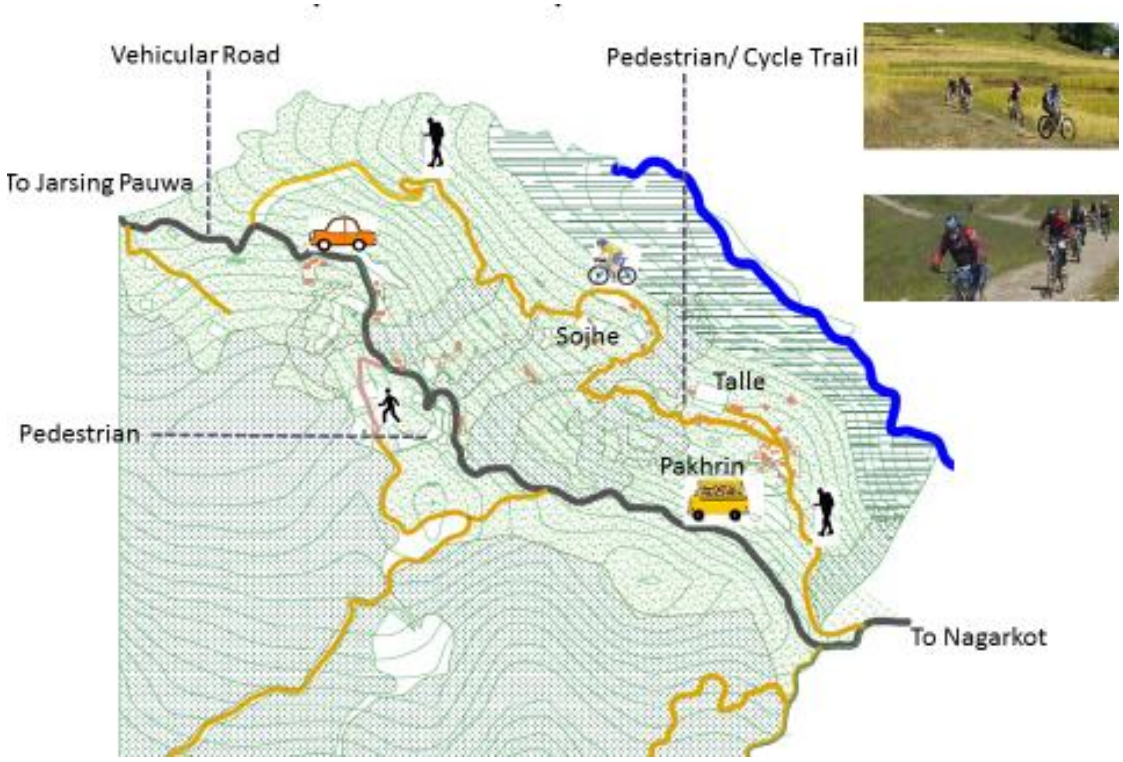



*Figure 13: Proposed Transportation Plan*

Fig: Proposed transportation plan 1

Primary road

Secondary road

Tertiary road

## 9.2. Cycling/Trekkng trail

Dhoksan is the trekking and biking corrider from Chisapani to Nagarkot. The flow of trekker and bikers is significant. Therefore, a proposed plan for the cycle and walking trails becomes important in inviting tourist to visit Dhoksan. The existing road presently is a vehicular, biker and pedestrian route. But since the volume of traffic is negligible, therefore segretation of road don't seems necessary. But with the proposed village plan, when the volume of tourist trafiic increases, the segregation becomes necessary. Therefore, the main street is proposed to have two different trails for the vehicles and the walker/ bikers to move. The visitors can also take an alternative route which begins from Jarsing Pauwa for those travelling from Chisapani and Kattike for those travelling from Nagarkot. In this route, the tourist gets to travel along the village area and the agriculture field.

Also for that tourist who take a long time package for staying in Dhoksan for days, can begin their biking from one end of the trail, where the tourist booths are located and making a loop end the ride at the start point. The average time for the ride would be 45 mins. Since both the routes for biking are steep at the starting point and in the middle. The ride will be adventurous to the bikers.

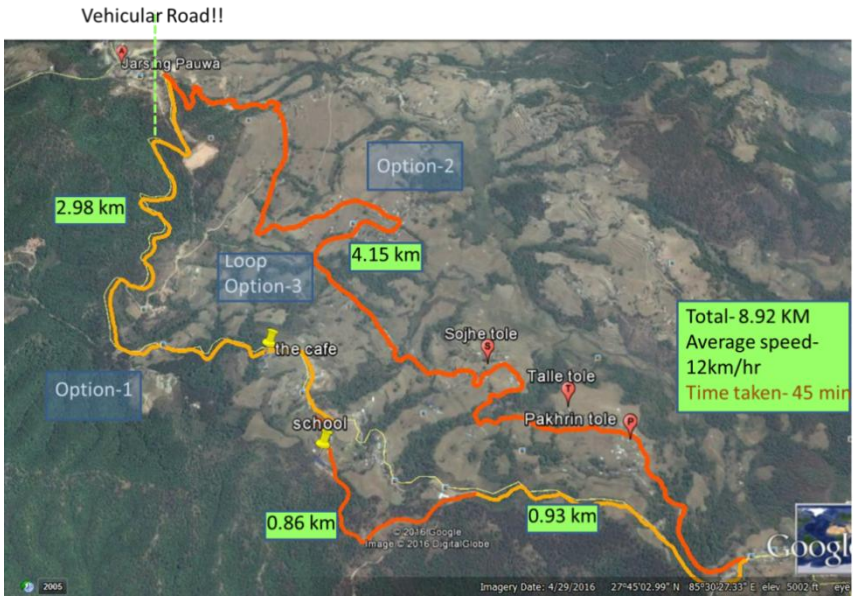



*Figure 14: Proposed cycle/trekking trail*

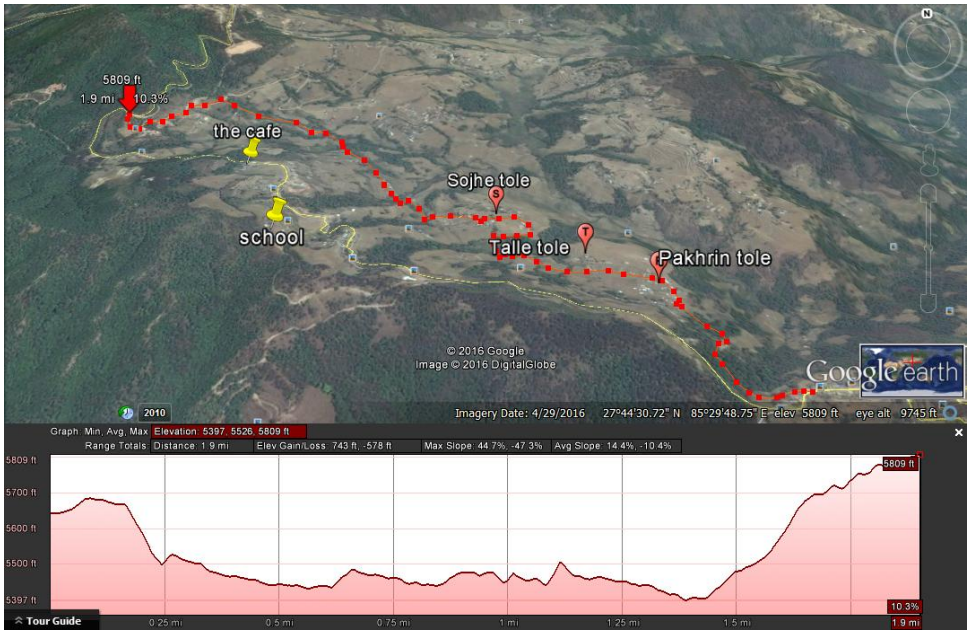



*Figure 15: The route of cycle trail and section 1*

## 9.3. Internet and Phone Charging Booth

ISP would be providing access to internet through wireless network, which would then be distributed through wireless routers. Mobile phone charging booths will be electrified by solar

PV cells, which will provide facility during power outage also. Since most of the young people are equipped with internet accessible mobile phones, this service would provide reliable communication.

The distribution points and mobile phone charging booths will be located in community zone. Number **1** distribution unit which would be located near the school premises can have strength of 100 meters, which will provide internet facility for students and nearby residents. Second distribution unit, **2**, of higher strength; here 500m, is placed near Bhukampa-karkhana. A booster router, **B**, with range of 500m, would be placed at Industrial zone. This communication facility will reach to settlements below primary road. One can go in the connectivity zone and use this community communication and charging facility. This new form of communication will facilitate promotion of Dhoksan village and will also connect Dhoksan with technological development.

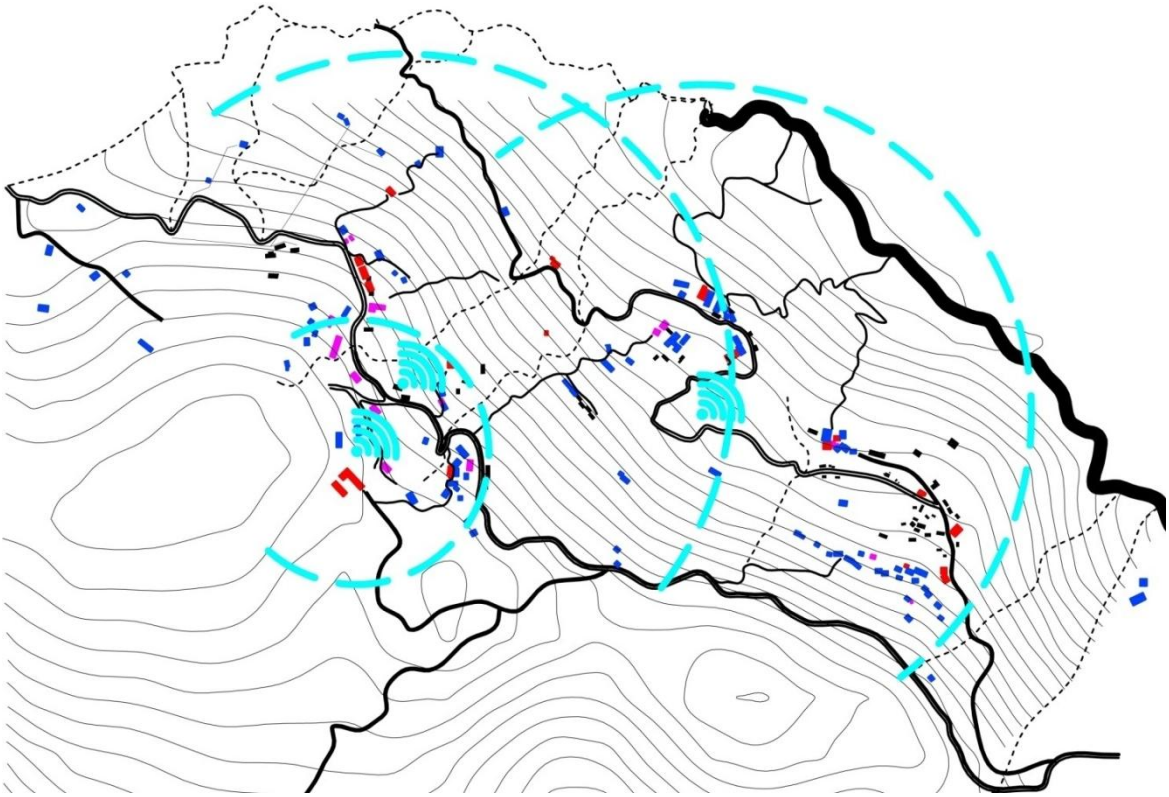


*Figure 16: Communication Plan*

# 10. ENVIRONMENTAL PLAN

## 10.1. Land conservation

Soil erosion has always been a hinderance in hill agriculture as it cause loss of nutrient rich upper layer of soil. Stabilizing gullies and digging cutoff drains can be done to prevent runoff from upslope from washing soil away. Contour ditch and cutoff ditch also helps in soil stability.

A contour is a ditch dug along the contour to stop water from running down the slope and causing erosion. Water stays in the ditch and gradually sinks into the soil. Contour ditches are useful to harvest water in dry areas. A cutoff ditch is like a contour ditch but has a slight slope, so water drains slowly away. Cutoff ditches are useful to protect fields from uncontrolled runoff and to divert water away from gullies.

*Figure 17: Fodder production on vegetative strip*

Another applicable solution in the slopes of dhoksan is vegetation strips. A vegetative strip is a strip planted with grass, shrubs or trees that runs across the slope. It slows down water flowing down the slope, and catches sediment that has been eroded uphill. Over time, soil may build up behind the strip, forming a terrace. Vegetative strips are cheap and easy to establish. Once they are growing, they are easy to maintain, and they can provide valuable fodder for animals.

## 10.2. Sanitation

### 10.2.1. Eco-san toilets

It is a surprising and unfortunate fact that Dhoksan, being close to Kathmandu city, lacks the basic sanitary services. Only about 10% of the household possess latrines. Promoting ecosan toilets in Dhoksan can be a sustainable sanitary solution addressing the present need of people.

Ecosan toilet is a safe sanitation solution that prevents disease and promotes health by successfully and hygienically removing pathogen-rich excreta from the immediate environment. It is environmentally sound because it doesn't contaminate groundwater and also saves scarce


*Figure 18: Eco-cycle*

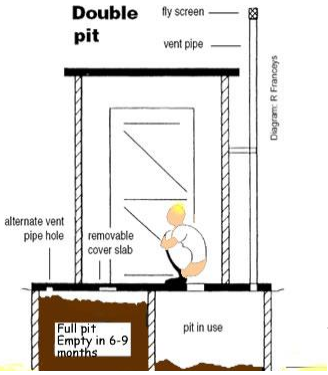



*Figure 19: Typical section of eco san toilet 1*

water resources. This technology comprises of a three-step process, dealing with human excreta: ie containment, sanitization (treatment) and recycling (WaterAid, 2008) . It recovers and recycles the nutrients from the excreta and, thus, creates a valuable resource to reduce the need for artificial fertilizers in agriculture. Thus, ecosan toilet is regarded as a holistic approach to call for hygienic, sustainable and ecofriendly technology that helps to maintain healthy humans and a natural environment by using affordable and appropriate technology.

### 10.2.2. Composting

Composting is a natural process of stabilizing bio-degradable material by a host of microbes – bacteria, actinomycetes, fungi etc. which may happen aerobically in the presence of free oxygen (air) or anaerobically in its absence (Mazumdar, 2012). It is the mechanism for recycling nutrients or converting organic matters to safer and useful product to enhance long-term soil fertility.

There are different ways of composting waste such as aerobic windrow composting, anaerobic trench composting and vermicomposting.

Aerobic windrow composting is by far the most popular method across the world. The technology is simple and flexible as the system can be designed based on the conditions at ground. But anaerobic trench composting is more popular in rural areas. Many rural families keep a trench near their household to deposit their kitchen waste and other green waste along with cattle manure. The pit is sealed when it is filled and left to get composted till the next cropping season, when the composted material is dug out and put in the field. Meanwhile, another trench is dug for continuing with the system. This method consume more time compared to aerobic composting.

*Figure 20: Trench composting*

*Figure 21: Vermicomposting*

Vermicompost is the product or process of composting using various worms, usually red wigglers, white worms, and other earthworms, to create a heterogeneous mixture of decomposing vegetable or food waste, bedding materials. Vermicast, also called worm castings, worm humus or worm manure, is the end-product of the breakdown of organic matter by an earthworm (Wikipedia, 2016). Vermicomposting is becoming more and more popular with passage of time. Users are becoming aware of the better quality and added benefits of using vermicompost.

Balanced fertilization of agricultural fields is crucial for securing food production. Now a days there is extensive use of chemical fertilizers that degrades soil quality and also pollutes water bodies. Composting can serve as essential supplement for chemical fertilizer for sustained production and minimizing use of chemical fertilizers. Composting has been practised in rural areas for centuries. Farmers traditionally put agricultural and some animal waste on their fields. Rural agriculture should be accompanied by farming relying on green manure, compost, biological pest control and crop rotation. It helps in improvement of long term soil fertility for better production leading to better livelihood of farmers. Therefore increased awareness, technical assistance and incentives for the use of compost is very essential for improving soil texture, moisture retention and plant nutrients present in it.

# 11. LIVELIHOOD PLAN

## 11.1. Present state of Dhoksan

According to the survey conducted by Bibeksheel nepami out of 58 houses and 309 populations, there are 14.6% of elderly people (55+), 53.7% of youth (18-55) and 31.7% of children (0-18). This shows people of economic age are highest in Dhoksan. Despite the fact, monthly income of 77% of families is below less than national per capita income i.e. Rs 0-20,000 where as only 23% of families income is greater than Rs. 20,000. The economic data from survey clearly shows that people are not able to engage in high income generating activities. From observation, it is also found that the main occupations of Dhoksan are agriculture and animal husbandry. The agricultural production is only in subsistence state. Recently women are engaged in winery as the benefit is comparatively more.

From the data above it can be concluded that majority of people of Dhoksan are economically poor because of unstable and not so well-paid jobs. Hence it requires plenty of income generating opportunities to reduce poverty. Special attention has to be made to women for empowerment.

### 11.2. Tourism Data of Dhoksan:

The purpose of national tourists is limited to picnic and leisure whereas that of international tourist is limited to trekking and biking. Their purpose of visit has affected the average period of stay at Dhoksan.

Likewise, no of national tourist visiting Dhoksan is 50-60 people per day in all months except May, June and July. This could be because rainfall is frequent and high in those months. And it is difficult to organize picnic on those months. But in case of international tourist, no. of tourist is maximum in September – October with 10-15 people per day which is the incoming trend of international tourist of the whole Nepal. The relation of the tourist inflow pattern and the activities in Dhoksan that can be concerned with tourism plays a vital role for the tourism development plan.

*Figure 22: Tourism data of Dhoksan*

### 11.3. Classification of potentials of Dhoksan as per month:

Based on the different literature and people of Dhoksan, an annual calendar is prepared so that tourist can know beforehand what they can see and observe in Dhoksan in different months. The calendar classifies cultural, agricultural and natural highlights of Dhoksan

| Months | Cultural | Agricultural | Natural |
|---|---|---|---|
| January | Sonam | Maize plantation, | |

| | | | |
|---|---|---|---|
| | loshar | | |
| February | Sonam Loshar | Maize plantation, | |
| March | | Wheat harvesting | Rhododendron |
| April | | Wheat harvesting | Rhododendron |
| May | Buddha Jayanti | Rice plantation, | |
| June | | Rice plantation, millet plantation | Wild Mushroom |
| July | | Maize harvesting, millet plantation, potato plantation | Wild Mushroom |
| August | | Maize harvesting, mustard plantation, potato plantation | Wild Mushroom |
| September | | Mustard plantation, | Mountain views |
| October | | potato harvesting | Mountain views |
| November | | Wheat plantation, millet harvesting, mustard harvesting, potato harvesting, | Mountain views |
| December | Tamo Loshar | Wheat plantation, millet harvesting, Mustard harvesting | |

In addition, the in depth understanding of the strengths and weaknesses of the tourism in Dhoksan is very important to come up with a holistic idea.

## 11.4. Strengths and weaknesses of tourism in Dhoksan:

**Strengths:**

Retention of rural character: village tourism

Hospitality and culture of people

Local handicraft skills and cuisines

Communities engaged in agriculture

A transit for Nuwakot to Chisapani trekking

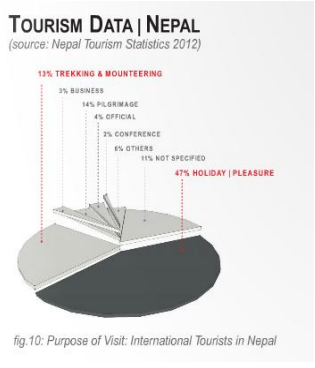



*Figure 23: Purpose of tourism in Nepal*

**Weakness:**

No marketing: People are unknown about this place. Even Google has not located this place in its map

Lack of linkage with Nuwakot and Sankhu: No public transportation
Lack of development of tourism related infrastructures

From the study of the overall scenario and the analysis of strength and weaknesses, the relevant solution can be drawn.

## 11.5. Satisfying solution: Agro-tourism

### 11.5.1. Agro –tourism:

Agro Tourism is when a native person or local of the area offers tours of their agriculture farm and allow a person to view and participate in sowing, harvesting and processing of locally grown foods (eg. maize, barley, grains etc).

### 11.5.2. Why agro-tourism in Dhoksan?

Dhoksan is agro-based village where major occupation is faming. Other ancillary occupations like animal husbandry, alcohol distillation are closely related to agriculture. It is Located in the hills at the height of 1800m from mean sea level and isolated from nearby capital city, it possesses a different lifestyle which is worth exploring.
There are three principles on which the exploreable activities or agro-tourism is promoted. (Vajiyan, 2014). They are:

- Something to see
- Something to participate
- Something to buy

### 11.5.3. Two possible tourism packages for Dhoksan:

**Short-time tourism package**

Short time packages are for tourists who come to Dhoksan for a day visit to enjoy local flavor of Dhoksan. Short time package shall majorly focus upon **something to see** principle. In this package the tourist can take a bike to travel, walk to the mushroom cultivated farm, visit the community forest and the grazing land, take a tour of the village and eat the local foods in the restaurants. Possible activities that can happen during short time package are:

- Short-cut village walk
- Rest at view deck

- Shopping at market centers
- Observation of Tamang agriculture
- Trying ethnic cuisines

**Long- time tourism package**

Long time package is designed for those tourists who want to spend more than 1 day at Dhoksan. It includes accommodation, eating facilities and participating activities. This tourism package shall enhance agro-tourism of Dhoksan. Though the schedule depends upon the visitor's objective, possible activities that can happen during long time package are as follows:

- Accommodation
- Regular village walk
- Volunteering in daily activities of local people: farming, milking, collecting fodders, organic farms
- Training and skills: handicrafts, participating in clean industries
- Learning ethnic cuisines, culture and festivals

### 11.5.4. Immediate Tourism infrastructures:

With the consideration of the principles as introduced above, the infrastructures can be developed as following.

*Table 1: Agro-tourism Business Portfolio*

| Fixed Attractions (Something to see) | Events (Something to do) | Services (Something to pay) |
|---|---|---|
| ➢Historic Plantations | ➢Agricultural fairs | ➢Farm tours and Agro-processing tour |
| ➢Agricultural Museums | ➢Local Festivals | ➢Rural Bed and Breakfast/Accommodations |
| ➢Village Rum Shops | ➢Special Events | ➢Rural Crafts, dress, agricultural products and foods |
| ➢Product and Crafts | ➢Food Festival | ➢Agro-trade with Tourism Operators |
| ➢Cultural Museum | ➢Rural Games | ➢Cycling/Walking Trail |
| ➢Animals, Birds and Nature | | ➢Ethnic Dress |
| | | ➢Buffalo Cart Riding |

### a. Tourist information center:

There will be two tourism information centers for Dhoksan: one at the border of Jarsing Pauwa and Dhoksan and another at the Kattike. The tourist information center at Jarising Pauwa shall cater the visitors coming from Sankhu whereas the tourist information centre at Kattike shall provide information to the tourists coming from Nagarkot. The tourist information center shall possess following requirements:

- Display map and special attraction of Dhoksan
- Internet facility
- Provide with the necessary equipment's while travelling
- Tourist package

### b. Tourist volunteer center:

Volunteer centers provide a platform for tourist who wants to participate in different activities. It shall help them identify what kind of activities are happening at which toles, precisely which house. For e.g.: During time of rainy season, there will be rice plantation activities in the field. At this particular time, tourist volunteer center can help tourist know whom they should contact if they want to volunteer in rice plantation. Other possible volunteer activities that are possible in Dhoksan are as follows:

- Teaching in Shiladevi Primary school
- Organic farming
- Afforestaion programme
- Plantation and harvesting

c. Village walk:

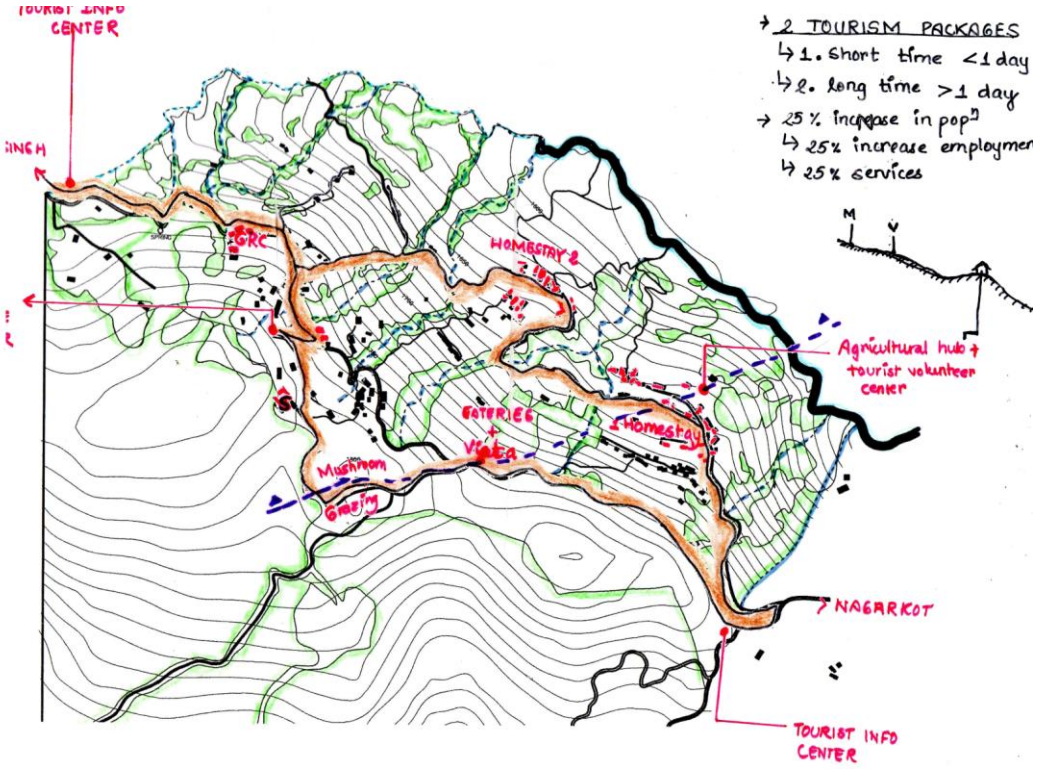



*Figure 24: Tentative planning of village walk*

Village walk is specially design for starts from the Gurans Rest Camp (Existing). Then it follows the main road i.e. Jarsing Pauwa to Nuwakot until it reaches to the Siladevi Primary School. Then trail climbs up to the tourist service center at the turning. The climbing continues till forest park where there will be provision of mushroom hunting during monsoon. Then trail climbs down to the view deck area. The view of mountain ranges from view deck shall rejoice the visitors. Then after, the trail leads to the kartike gaon and to the Pakhrin Gaon. Katike Gaon lies beyond our proposed village area. Pakhrin gaon,, Talle gaon and Sojhe gaon are three major settlements of Dhoksan. Pakhrin is one of the major earthquake hit settlement of Dhoksan that lies below the main road. In between Pakhrin and Talle tole, there will be an agricultural cum tourist center where tourist can participate in different volunteer activities. After the trail pass Sojhe tole, the trail climbs up to the vicinity of Gurans Rest camp where village tour ends. There shall be some other facilities like eateries, hotels, washrooms etc. Beside a major village tour, there shall be other short cut roads to cut off time.

**Regular village walk**

Total distance of village tour from GRC to GRC = 3711m

Average walking speed of man = 1.4 m/s (Human behavior-Walking, 2014)

Total time taken = 2650.72 s = 44 mins

But assuming 15 mins for rest during the village tour,

It would take minimum 1 hr. time for village tour

**While using short-cut walk**

Total distance of village tour from GRC to GRC = 2964 m

Average walking speed of man = 1.4 m/s

Total time taken = 2117.14s = 35 mins

But again assuming 15 mins for rest during the village tour,

It would take minimum 50 mins for village tour.

The time of stagnation at the view deck is not considered.

d. View deck:

This is the place where visitors can discover why Dhoksan is called Sano Nuwakot. Some other facilities has to be developed at this place like binoculars, resting place, eateries, stoppage for village walk.

e. Homestay:

For the tourism, home-stay is proposed rather than resort. One room extra is to be added in the existing and new residences which are to cater home-stay. This will not only make the host (people of Dhoksan) adopt the idea easily as it is economically affordable rather than resort but also allow the tourists to have the opportunity to experience the local lifestyles and cultural practices. The essence of their physical, social and cultural values can be hence valued.

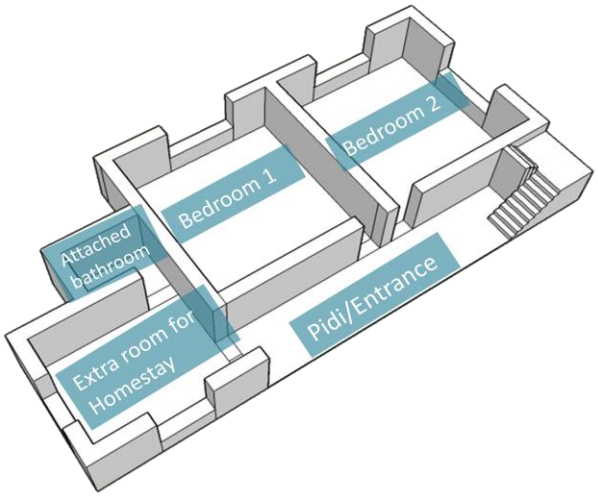



*Figure 25: possible layout of Residence with Home-stay*

Maximum number of national tourists = 50-60 per day

Maximum number of international tourists = 15-20 per day

Total maximum tourists = 65-80 per day

Assuming 60% of the maximum tourists = 48

So,

Total number of homestay = 1/2

Traditional homestay(50%) = 24

New constructed homestay(50%) = 24

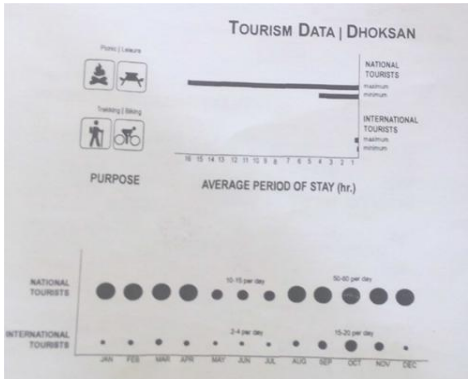



*Figure 26: Tourist Data from Bibeksil Nepali*

**Requirements of home stay:**

- Solar water heater
- Wifi Connection
- Electricity (Charging mobiles etc)
- Attached Bathroom

### 11.5.5. Forward and backward linkages:

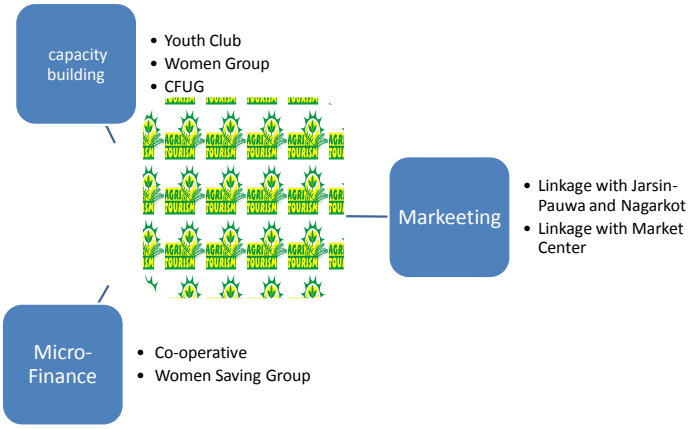



*Figure 27: links with social and economic capital*

### 11.5.6. Impacts of Agro- tourism in Locals:

- It shall promote the agriculture and its supplementary activities.

- It creates the platform to exchange the culture.
- It helps local people to generate social, economic and natural capital.
- It shall uplift lifestyle of people.

## 11.6. Promoting animal husbandry: **Plantation of quality fodder**

### 11.6.1. Present scenario:

Based on the limited interviews with local people, it was known that different livestock are reared at Dhoksan for different purpose.

| Type of cattles | Purpose |
|---|---|
| fowls and poultry farms | Eggs, meat |
| Goats | Meat and commercial sell |
| Cows, oxes | Milk, ploughing |
| Buffloes | Meat and milk |

For proper rearing livestock, the fodder is important. Poultry requires corn and soyabean and Dhoksan climate favors both crops. Likewise for fodder, at present leaves of Uttis, Bakaino are used as the fodder (Mishra, 2012). Other quality fodders that can be developed at midhills are Napier grass, Amrisho etc (Shrestha, Sanjyal, KC, & Kandel, 2007) :

### 11.6.2. Comparison matrix for quality fodder:

| Parameters | Napier (Sthapit & Tennyson) | Amrisho (Flora of Nepal, 2016), (Samuel, 2011) |
|---|---|---|
| Land topography | Steep lands | Steep hills<br>Sandy banks of rivers<br>Damp steep banks along ravines |
| Advantages | Erosion control<br>Adapt to wide range of fertility and moisture<br>Aggressive reproducer<br>Grow with indigenous trees of Dhoksan | Green forage<br>Broom making<br>100 running meter area : income of Rs. 2000 per annum<br>Reduce soil erosion |

| | | |
|---|---|---|
| | Quality fodder | |
| Harvesting intervals | 6-8 weeks<br>May to October | 2-3 times in a year<br>After mid-November and mid January |

From comparison matrix, it is clear that napier grass can be a good option for quality fodder but then if some immediate economic benefits are required than amrisho is more appropriate.

#### 11.6.3. Impacts of development of pastures:

- Haphazard grazing can be stopped
- The milk and meat production can be increased
- It eases cattle farmer for collection of fodder
- Encourage animal husbandry

## 11.7. Adding the value of corn: **Branding**

### 11.7.1. Present scenario:

Branding corn is proposed as an activity to increase the value of corn and increase financial return. A question may arise why corn and why not rice or wheat. The reasons for selecting the corn for branding are as follows:

- Corn was the answer given by a participant in workshop when we asked what can Dhoksan make famous if Khokana is famous for mustard and bhaktapur is famous for curd.
- The climatic condition and sandy loam soil of Dhoksan is appropriate for maize cultivation.
- There is existing local knowledge for cultivation of maize
- High demand of maize: The demand for maize is also shifting from food to feed for livestock and poultry. Maize demand is increasing at the rate of 11% per annum in Nepal. For foods, new types of maize-based products such as soups, vegetables, edible oil are in demand. Likewise to fulfill the growing demand of milk, meat, and meat productions, 45% of maize is being imported from India (Govinda, Karki, Shrestha, & Achhami, 2015)

### 11.7.2. Problem identification for branding of corn:

- Production of maize is not sufficient as per farmer's effort.
- There is no any training for farmers for modern method of cultivation

- Access for improved seeds, consultation and supervision is lacking
- Proper marketing strategies are missing for branding

### 11.7.3. Infrastructure for corn:

**a. Bhukampa Karkhana:**

It is a place where farmers get trained for surplus maize production by the experts. The lectures, video demonstration and workshops can happen here to educate people about the new and improved technology

**b. Agricultural hub:**

- From agricultural hub, the branding shall start. The collection of surplus corn from famer, its grading, storage and separation shall happen here. The packaging of various types of corn shall be done depending upon the grade, use and state.
- An expert shall visit here on timely basis so that farmer can talk about their problems of their farms and ask for immediate solutions.
- Likewise, there shall be store for improved agriculture equipments such that farmer can hire the tools in turn like existing perma system
- there shall be a co-operative which can provide small loans or micro finance fro promoting agriculture.
- for proper communication among farmers, a local FM station can be proposed in order to provide the market price of agricultural product at different marker centers at it vicinity

**c. Agricultural mills:**

Since existing seasonal agricultural water mill is not sufficient even for residential purpose, an improved agricultural mills is very necessary for proper grinding that can be used for both residential and commercial use all the time. As it is mentioned that the demand of maize for feedstock is very high, poultry feed mill can be started as well.

**d. Market centers:**

The market shall not only limited to Dhoksan itself but it shall extend even to Jarsingh pauwa, Sankhu, Kathmandu, Nuwakot. So there should be proper linkage in terms of communication as well as transportation.

**e. Transportation:**

The development of transportation is very important to increase the market of corn of Dhoksan. Considering the present situation where there are no any public vehicles, it looks like a separate concern has to be given for transportation. However, it should be always kept in mind that even if there will be an access of different transportation means, there should be certain areas where the means of transportation shall strictly be of rural character.

### 11.7.4. Marketing strategies:

a. *'Cornfectionery': Corn based food stall*

Corn is one of the major products of Dhoksan, during rainy season. Corn has also established itself as street-side confectionary shop since past. Vendors have handy setup where they roast corn on firewood, which can also be replaced by other renewable fuels, such as, bio charcoal. The corns can also be boiled. Similar business can be run if a chain can be made with centers, where these 'Cornfectionary' stalls can become outdoor eatery. Since, Dhoksan is close to Kathmandu and Nagarkot, it has huge potential to have travelers' attention. This would also improve rural-urban linkage. In this way value addition on agricultural produce can be achieved.

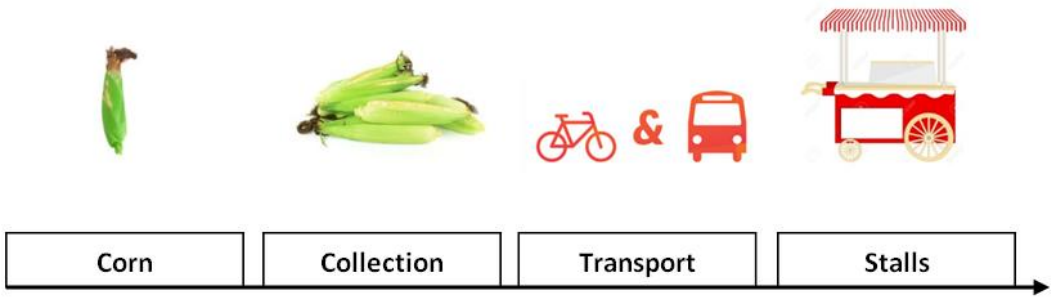



Fig: 'Cornfectionary' components

## 11.8. Increasing efficiency of fields: **Irrigation**

The agriculture practice in Dhoksan Village is entirely dependent on direct rainfall. The availability of water is non-uniform and very limited thus the crop pattern at present has been aligned to adjust the prevalent water scenario. Maize, Wheat, Beans, Peas, Millet, Potatoes, mustard are the major crops, with the low crop water requirement that are cultivated at Dhoksan. Vegetables such as Tomatoes, Cabbage, Cauliflower, Garlic, Onion, Chilies are grown at the

yard for household use. Similarly the crop with high crop water requirement like paddy is cultivated in limitation by the utilization of the monsoon rain.

*Figure 28: Agriculture field irrigation*

The present practice of irrigation is very primitive that includes the channelization of the water from the available gullies to the adjacent field, storage of the water at the terrace field by the formation of the bunds. For the current crop pattern the water requirement is fulfilled from the rain fall however for the assurance of food security even with the considerable moderation in the climate, the change in crop pattern as per the need of increasing population and the scaling up of the agriculture to commercial level, a reliable irrigation system is very desirable.

With the concern on the priority of the utility of the water on domestic purpose over the additional water requirement for agriculture, the irrigation can be done in two ways. With the increase of paddy field the water requirement is increased. Lift irrigation could be possible where the water from the river is pumped up by solar water pump, stored in a reservoir and released over the contour canal or the sprinkler as per requirement of the crop. In other hand the water can be reserved over the furrow land by constructing swales or retention pond. The field can be thus irrigated by contour canal. For the vegetable farming drip irrigation can be done. As bamboos are abundantly available at this place, Bamboo can be used as the dripping channel and the volunteering tourist can be

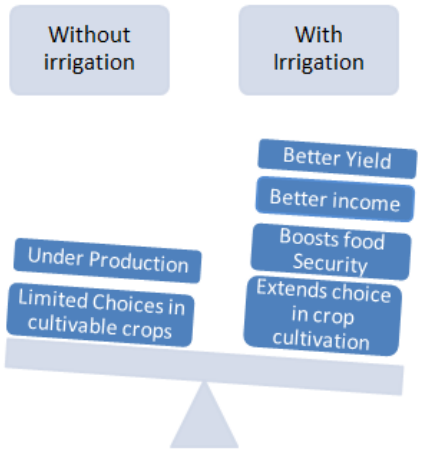



*Figure 30: Benefits of irrigated field over non irrigated one*

*Figure 29: Tunnel Farming Source, TECA*

mobilized to carry out such works.

### 11.9. Increasing vegetable production: **Tunnel farming**

At present vegetable farming is done at the yard for self- consumption. Scaling up this farming to commercial level would be one of the appropriate options for the income generation and conservation of farming practices. The organic vegetables have a vibrant market over the cities nearby. With the tourism development plan the requirement of vegetables is likely to increase in Dhoksan itself. Nagarkot can be the other possible market. Considering the limited availability of water, the vegetable farming with certain moderation over the practice can be promoted for the socio-economic development of the Dhoksan Village.

Vegetables are a required source of vitamins, proteins, essential nutrients and carbohydrates for a balanced diet. In the hill, farmers are limited to grow seasonal vegetables and are dependent on marketing mechanism of demand and supply. Growing off-season vegetables and fruits means improving the diet and increasing the household income. In the absence of storage infrastructure and vegetable processing industries, off-season vegetable farming is the viable option that can add value to the farmers' produce.

The tunnel farming offers maximum crop yields, better maintenance of the fertility of land, controlled temperature and humidity, protection from wild animals and insects and better water conservation. Building tunnel structures is inexpensive and relatively easy.

The tunnel must preferably be situated close to a market, in order to facilitate that products reach the market place as soon as possible. Crops such as cucumber, capsicum, tomato, pepper, bitter gourds, melons, brinjal and water melon are highly valued vegetables that show significant increase in yield when grown in tunnel farming. In water shortage areas, the most efficient use of water are through drip irrigation, maximizing the use of water, as well as fertilizers, applied though drips as *fertigation*, especially in the initial growth stages.

### 11.10. Other potentials: **Mushroom**

From literature and field visit, it was known that Kusum Community forest, Dhoksan grows various edible and non-edible mushrooms. Also from literature study, it was found out that there are basically two type of edible mushroom that can grow at the altitude of 1810m i.e. Kusum community forest. They are

- *Lentinula edodes (shitake)*
- *Lycoperdon pyriforme*

**a. Lentinula Edodes (Shitake):** (parajulianish, 2015)

It is recognised for its multiple nedicinal properties like curing tumor, high blood pressure and diabeties. This mushroom is cultivated at the altitude of *1700-2500 masl where Alnus nepalensis* (Uttis) and *Castanopsis cuspidate* are found.

*Figure 31: Shitake*

**b. Lycoperdon Pyriforme:**

It is commonly known as the pear-shaped puffball or stump puffball, is saprobic fungus. Emerging in autumn, this puffball is common and abundant on decaying logs of both deciduous and coniferous wood. This is considered edible when still immature and inner flesh is white.

This place has a potential to develop as forest park and major tourist attraction where tourist can hunt mushroom for a while. A scheme can be developed where tourist can collect mushroom in bamboo bucket on hour basis. There can be a provision of concession in collected mushroom while they buy for it. This particular place can provide some work opportunities for supervision of mushroom collection and screening of mushroom collection. Further it can promote the local bamboo crafts. Also it can encourage local people to retain forest, indigenous trees as forest itself can be platform for income generation.

**c. Mushroom Cultivation:**

Mushroom is an immense potential crop in terms of food nutrition, medicine and good economic value. At present White button mushroom ( Latin name: Aqaricius bisporus) and Oyster mushroom are the two commercially cultivated mushroom in Nepal. One of the reason for its popularity is the short growing period between the cultivation and harvesting which is only about two and half months. Smaller land holder farmer can get high return in short period of time. The mushroom tunnel is constructed out of the locally available

*Figure 32: YPARD Nepal Mushroom Farming*

material such as straw, bamboo, wood etc. In addition to it Plastic and polyethene bag is also required. The initial investment for the mushroom including tunnel (15'*30' ) seed and the entire setup is about Nrs 45,000. (Bibeksheel, 2014) The cost could possibly be less for the Dhoksan as the material specially the straw from the paddy field are locally available. The cultivation of the mushroom shall be done as per climate situation. The temperature of the tunnel has to be maintained which is 10-15 degree Celsius for the maximum production of Oyster mushroom. The cultivation of this type of mushroom is relatively easy. In other hand button mushroom remains the most highly cultivated mushroom throughout the world even though the actual culture is extremely complex. It requires the fabrication of a very specific compost and a layer of casings. During the cultivation of the button mushroom, the casing is laid over the incubated mycelium, which makes this process difficult because the compost must not be sterilized though it must only contain beneficial bacteria for the fruiting of the mushrooms. The casing is usually made up of sphagnum moss, although vermiculite or coconut coir can also be used. (Parajuli, 2015). Though mushroom is organic farming necessary measures has to be taken outside the tunnel in order to protect it from unwanted bacteria. Mushroom cultivation needs a better attention and hard work as to get the maximum yield however there is great scope for the market. At current the major issues with the mushroom cultivation is lack of adequate knowledge of the farmers and required policies and support from the government. Thus with the proper knowledge and training to the locals, the mushroom cultivation has indeed a great potential for the agro-economic development.

**d. Distillery**

Alcohol has been an integral part of Tamang community. It is prepared in most of the households and has importance in cultural proceedings. Corn and wheat are primarily fermented to make alcohol. This cultural activity can be a potential economic source, if the produce could be regulated and sold out to the market.

The distillery could be managed by community, as it would regulate and manage functions for quality control. Since the energy requirement for alcohol production is high (during distillation), there needs to be alternative energy sources to firewood, which is currently practiced. Substitute of firewood can be cleaner sources of energy like electricity and briquette. The consumption of firewood could also be reduced by use of improved cooking stove (ICS).

Raksi, alcohol, making process in Dhoksan is carried out with minimal setup. It is essential for a produce to have standards, which is difficult to achieve from individual collection. However, there can be workshop which would provide knowledge and, if possible, instruments, based under certain criteria. This would facilitate individuals with improved production and possible ways of generating income by selling it.

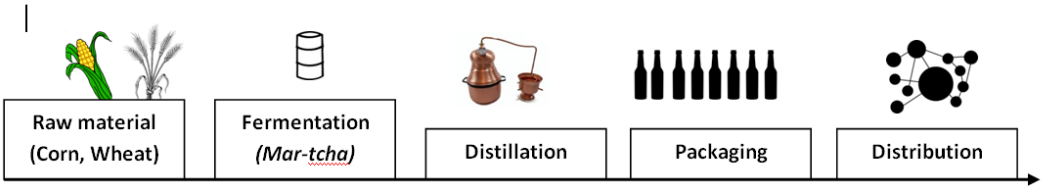



Fig: Processes involved in distillery

*Figure 33: : Processes involved in Distillery*

### 11.11. Overview on livelihood plan:

Several activities are proposed for reducing the poverty by generating different income generating opportunities. All the proposed activities are based on the limited field study. For analysis on implementation, further detail study had to be carried out.

## 12. ENERGY PLANNING

In energy planning, three basic elements of Dhoksan have been looked into profoundly. Buildings, Agriculture and Farmers, these are the basic elements which Dhoksan seems to be comprised of. Since, agriculture is the economy of most of the inhabitants of Dhoksan and that is also an identity of people in there, energy use is important to be critically analyzed so that the energy planning can be done with increase or at least retains the agriculture which they practice. Also, many of the buildings after earthquake has been demolished in Dhoksan and thus, it can be predicted that there will be new houses constructed in near future. The modern construction materials having lower embodied energy should be taken into account.

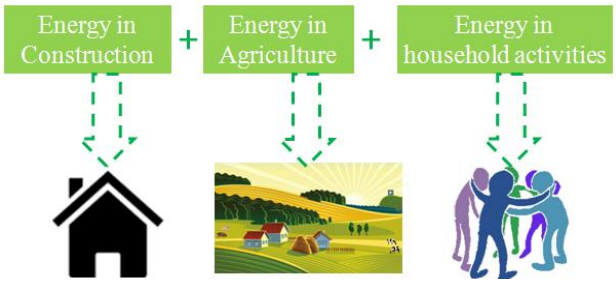



*Figure 34: Energy Planning*

Thus, the energy planning in buildings is also explored. Furthermore, energy use can be controlled by the people to maximum extent and so, the contribution from the people's activities in energy planning is also examined.

## 12.1. Energy issues

There are energy issues which have to be fully accessed first so that the propositions made can be realistic and practical. Some of the energy issues for rural areas are as follows:

- Access to energy sources by poor
- Affordability of energy
- Public transport-improvement and access
- Air quality-indoor and local
- Renewable energy
- Energy efficiency
- Economic competitiveness (relating to energy cost)

## 12.2. Energy Use

**In Buildings:**

If sector wise energy has to be considered, building sector will top the chart being the highest consumer of energy. Transport sector. Building sector and industrial sector if accessed, Building sector is the largest energy consumption sector during construction, implementation and dismantling stages. Though there has been energy saving ideas and technological improvements in buildings which definitely improve comfort, health and aesthetics but designing and building a new energy efficient house is a challenging job. Especially for the country like Nepal, the energy saving technologies is new. The materials should be brought from abroad which adds on to the total cost of building. Furthermore, the maintenance also seems to be unrealizable since the labors are unskilled to deal with the new technologies which will make project unsuccessful. However, the energy conserving and saving ideas which are easy to execute, handle, operate and are affordable can be implemented.

If the case of Dhoksan is to be considered, firstly, it is a rural area and secondly, the economic status of the people is not that sound. Hence, proposals regarding construction should be simple and affordable.

**In Agriculture:**

Agricultural sector uses high amount of energy in the developed countries as they use Diversified Farming which yields more with the incorporation of new technologies whereas very low energy is invested in agriculture sector in developing country like Nepal. Despite this fact, one cannot ignore the human labor that is spend in agriculture which makes the production very human laborious and inefficient. The technological inclusion which promotes to the conservation of energy and uses clean energy for operation shall be put forward. The benefits then can be envisaged to not only enhance the productivity of the crops but raise the income level of the economically weaker section of people residing in the rural areas thereby saving the intensity human labor devoted.

In Dhoksan as well, conventional methods of agriculture is used at present context which accounts to very less energy use in agricultural sector though the disadvantage of conventional method of farming is lower productivity and intense human labor which is required. The slope terrain land of Dhoksan can be well utilized for the gravity flow of water required for irrigation in energy efficient manner and with strategies which is eco-friendly and can reduce the human labor simultaneously.

## 12.3. Energy Planning in Building Construction

Embodied energy of the building materials should be given much priority. The material which has less embodied energy and is environment friendly has to be given preference. Most of the modern construction materials contains high embodied energy and are hazardous to the environment such as Aluminum, steel etc. Looking at the present context of Dhoksan, there is a probability of using local materials as their construction materials which are eco-friendly and contains low embodied energy as well. Bamboo can be taken as a good example of it but execution of these materials in modern time can be challenging job. However, if certain modifications are to be done in the technology than definitely positive can be expected.

Modern materials contain embodied energy much higher than the vernacular materials and hence their utilization in buildings is a matter of concern. However, there are materials which have low value of embodied energy which can be a part of new buildings which are to be built in future. The materials which can be manufactured has to be given more importance though. Furthermore, the materials which has the possibility of being re-used, re-cycled and are bio-degradable shall be prioritized. Given below is the embodied energy of materials used for the building construction:

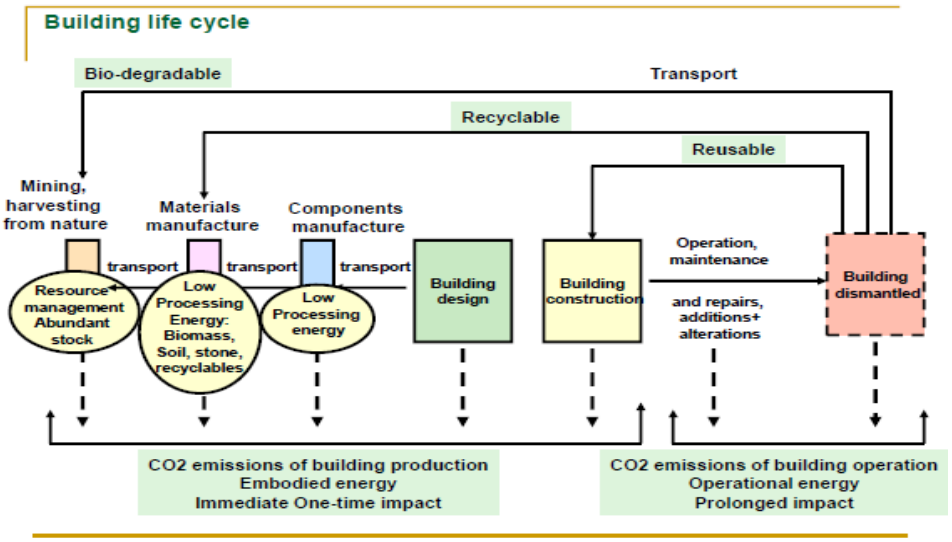



*Figure 35: Building Life Cylce, Source: (Parakh, 2008)*

**Energy planning in Building Construction in Dhoksan**

In the present scenario, there is a transition that is taking place from traditional buildings to RCC buildings. This is accelerated by the earthquake that struck in 25th April 2015 which demolished a lot of buildings, especially traditional ones. The people's perception has also been seen to change towards traditional buildings and prefer RCC as they take it as safer and disaster resilient than traditional buildings. The physical fact shows that most of the traditional buildings were demolished but the reason behind it getting demolished is a topic of concerned because there exist other rational reasons such as age of the buildings, low maintenance etc. The awareness about these things will take a long time and before that, the construction of buildings can't be withheld and hence the modern construction materials having lower embodied energy are taken into account.

At present,

Total number of buildings in 2005 = 103

Total new buildings in 2010 = 18

Total new buildings in 2015 = 19

Total new buildings in 2016 after earthquake = 55

Assume, 90 % of new buildings are temporary shelters

So,

**Total number of existing houses excluding temporary shelters = (103+18+19+5) = 145**

Again,

Population size (2016) = 740

25% of population = 185

Average family size = 5

So,

**Total new buildings that will be built = 35**

It is clear that new buildings will be constructed and hence there is a need of proposing strategies which can make work of construction efficient by taking the role of energy efficiency in corresponding.

Firstly, the present scenario is analyzed properly in respect to building construction and then the feasible strategies are proposed so that it can be realistic approach. After the propositions, their impacts are also taken into consideration to see whether the proposals are rational or not.

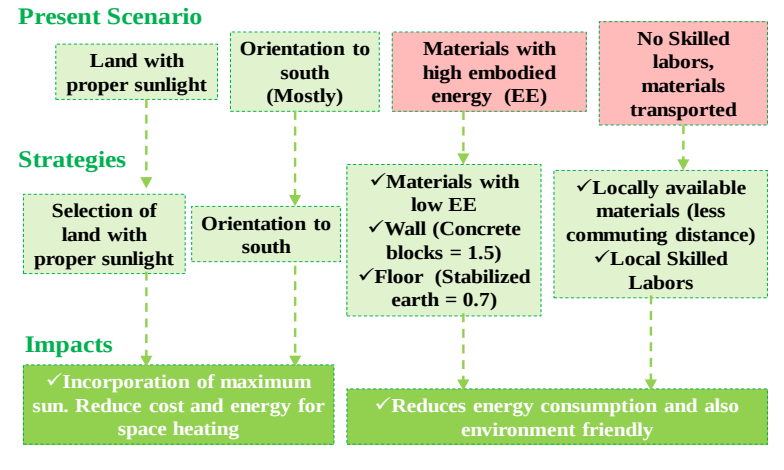



*Figure 36: Energy saving in Building Construction*

### 12.3.1. Strategies in building Construction

- **Land with proper sunlight and orientation**

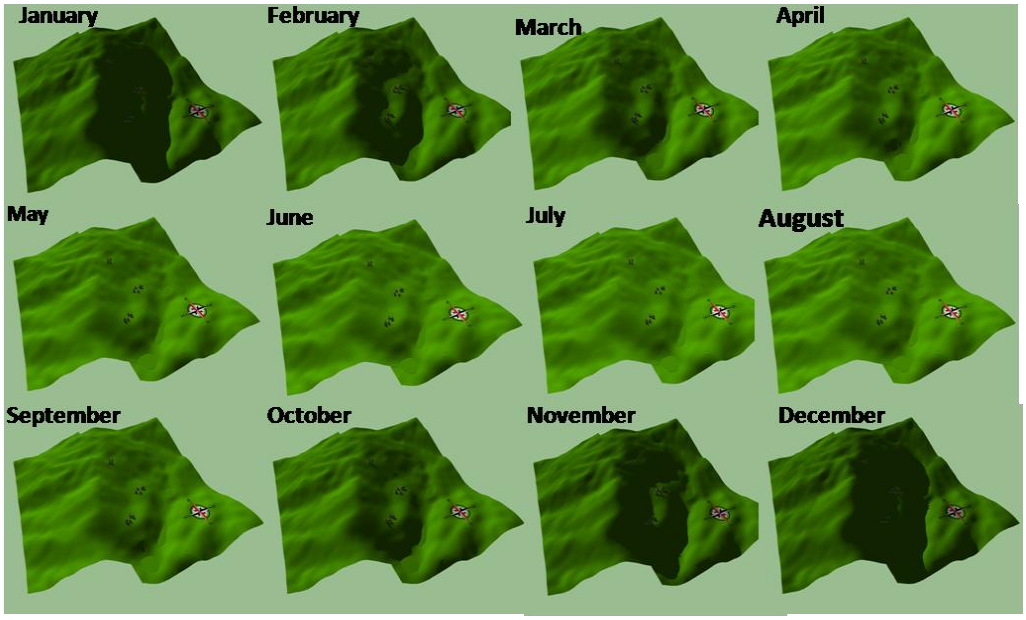



*Figure 37: Shadow casting throughout the year in Dhoksan*

Built forms especially residential houses are built in places which obtains high sun hours. This is also reflected in Dhoksan where all the toles including Pakhrin tole, Sojhe tole, Talle tole as well as Charjakhala tole are built in areas which acquire high sun hours throughout the years.

It is very important to consider sun hours per day from winter to summer to propose residential zone. The activities of rural like drying of crops, sun bathing and so on revolves around sunny areas and so the zone adjacent to the existing residential zone is proposed for compactly dense settlement so that sun rays can be trapped for longer hours. Also, the buildings are proposed to be constructed in south orientation so that maximum amount of solar rays can be taken in. The benefit of these proposals can also be seen in reducing the energy cost and investment which is required for space heating and naturally heating the space without any additional energy requirements.

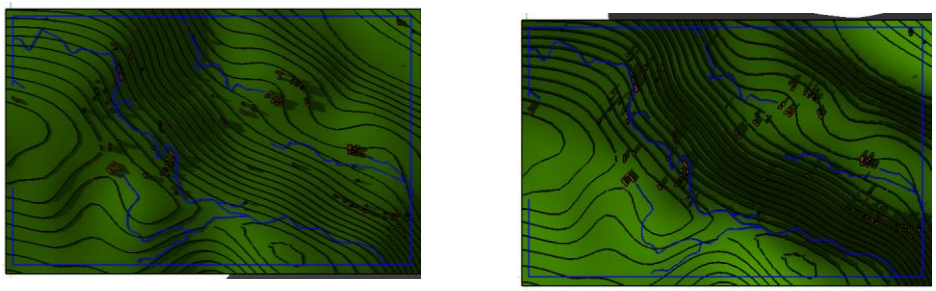


*Figure 38: Winter and Summer sun shade in Dhoksan*

- **Use of materials with low embodied energy**

CSEB blocks:

CSEB are most the time cheaper than fired bricks and concrete blocks. In Auroville, a finished m3 of CSEB masonry is always cheaper than fired bricks: between 15 to 20% less than country fired bricks (April 2009). The cost breakup of a 5 % CSEB produced in Auroville with an AURAM press 3000 is as follow (July 2012):

| | | | |
|---|---|---|---|
| Labour (soil sieving and block making): ~45 % | Raw materials (soil, sand, water): ~ 27 % | Cement: ~25 % | Equipment: ~3 % |

*Table 2:Cost Effectiveness of CSEB Block, Source: (Auroville Earth Institute)*

CSEB blocks can be a good option for Dhoksan. The raw materials required for the blocks are easily available and the production of these blocks also does not require high qualification and complications. The installation cost is also minimum which requires small pressing machine and local people can be easily trained for using the pressing machine to produce these blocks.

| INITIAL EMBODIED ENERGY PER $M^3$ OF WALL | POLLUTION EMISSION (Kg of $CO_2$) PER $M^3$ OF WALL |
|---|---|
| CSEB wall = 631 MJ / $m^3$<br>Kiln Fired Brick (KFB) = 2,356 MJ / $m^3$<br>Country Fired Brick (CFB) = 6,358 MJ / $m^3$ | CSEB wall = 56.79 Kg / $m^3$<br>Kiln Fired Brick (KFB) = 230.06 Kg / $m^3$<br>Country Fired Brick (CFB) = 547.30 Kg / $m^3$ |

*Table 3: Embodied Energy of Walling Materials, Source: (Auroville Earth Institute)*

**Bamboo wall:**

*Figure 39: Siladevi School in Dhoksan*

Another possibility seen in Dhoksan is wall made of sand block and bamboo. As bamboo is a vernacular materials available in Dhoksan and is eco-friendly as well, a wall comprising of bamboo and sand blocks can be a bright possibility. The school building which is recently constructed has also utilized bamboo wall and is working properly. Apart from all these benefits, the regular maintenance of bamboo and the requirement area and chemicals necessary for treating bamboo still remains a matter of concern.

A research carried out shows that the use of composite wall comprised of bamboo an d sand blocks is capable of producing embodied energy efficient (Vincentius Totok Noerwasito, 2014). Both the materials, bamboo and soil block have relatively low embodied energy. A model of 3 x 3m was used to carry out the research in which the wall is 2.8 m high consisting of five different compositions of wall. The composition of wall was variably research in which a composition obtained of high of soil block wall and bamboo wall was 1 : 1.8, which produced wall with embodied energy efficient.

| building elements | Embodied energy | |
|---|---|---|
| Bamboo wall | 2400 | $MJ/m^2$ |
| Soil block wall | 6818,18 | $MJ/m^2$ |
| Stone foundation | 235,18 | MJ/m |
| Clay tile | 251 | $MJ/m^2$ |
| stucco floor | 5250 | $MJ/m^3$ |
| Window | 388 | $MJ/m^3$ |

*Figure 40: Embodied Energy of building materials, Source: (Vincentius Totk Noerwasito, 2014)*

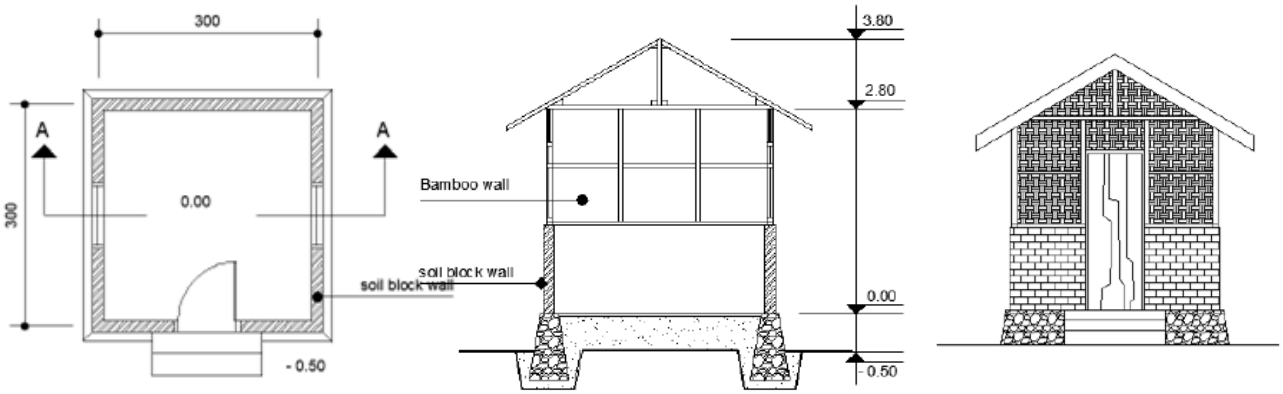



*Figure 41: Building made of Soil Block and Bamboo, Source: (Vincentius Totk Noerwasito, 2014)*

Plan of building Section of building Elevation of building

These are the proposals for wall construction. Likewise, there are other materials than conventional ones for roof and floor which is suitable with respect to strength as well as low embodied energy. From literature, it was found out that the existing materials used in the modern buildings can be replaced by the materials having lower embodied energy without compromising the strength of the building.

In the case of Dhoksan, it was seen that, roof of most of the buildings (traditional) was replaced with CGI sheet. That may be due to the reasons such as durability, low maintenance etc. though there are many advantages of using the materials but that cannot skip the fact that the materials has intense negative impact on the environment. Thus, the alternatives of these materials shall be considered. With technological innovations, modifications to traditional used materials can be done and achieve the co-benefit of being environmental friendly as well as reduce the embodied energy being lost during the production. As the table above explains, the timber frame with sheet sheet can be replaced with timber frame, terracotta tile and plasterboard ceiling for roof and concrete slab on ground can be replaced by elevated timber floor for floor thereby reducing embodied energy to 271 and 293 respectively.

| | Existing Modern Buildings materials | Embodied Energy per square meter of construction | Materials with low embodied energy | Embodied Energy per square meter of construction |
|---|---|---|---|---|
| Walling | - | - | - | - |
| Roof | Timber frame, steel sheet | 330 | Timber frame, terracotta tile, plasterboard ceiling | 271 |
| Floor | 110mm concrete slab on ground | 645 | Elevated timber floor | 293 |
| Windows/Doors | - | - | - | - |

*Table 4: Replaceable materials having low embodied energy*

*Figure 43: Suspended Beam Floor in Bhukampa Karkhana*

*Figure 42: Bhukampa Karkhana*

The suspended floor was witnessed in Dhoksan as well in the Bhukampa Karkhana. The suspended RCC beam floor was said to be Japanese system by one of the locals of Dhoksan. However, this system of construction is not new since the traditional buildings of Nepal of Rana period also contains suspended timber floor.

- **Use of locally available skilled labors and materials**

At present in Dhoksan, the local labors are unskilled and the people hire labors and the materials such as bricks, steel rods and cements from outside Dhoksan. It can be deduced that the cost for constructing buildings is raised and in parallel, there is large amount of energy wasted in transporting it to Dhoksan. So, the propositions are to skill the labors inside the local area so that the energy wasted in transportation can be conserved and in equivalent to that, the employment opportunities to the locals can be provided if they are trained and create affordability aspect in construction.

## 12.4. Energy planning Agriculture

Thoughtful implementation of energy-efficiency improvements in agricultural equipment will help reduce the cost of food production. When considering the area of food production alone, second largest end use in agricultural equipment after the share on fertilizers and pesticides in U.S. (Gellings). However, the situation is not similar in Nepal as it mostly practices conventional method of farming with organic fertilizers which are produced as a byproduct of houses. But some interventions is required in the traditional method of farming of Nepal in order to increase the crop per drop and also to some extent reduce the human labor with some efficient innovations which are cost-effective as well.

**Energy planning in Agriculture in Dhoksan**

The situation of Dhoksan is quite similar to the hilly rural areas where most of the people are engaged in agriculture as their main occupation but sadly, the youth of the area have started to migrate abroad in search of employment opportunities. This will in the long run have a great impact on the agriculture sector which they possess also as their identity. If by some technique, the value addition can be done in the agricultural crops and can be commercialized provided with markets for selling their crops at optimum price from where they can gain maximum profit then, the migration rate can be slow down and more people will stay in Dhoksan. The affordable technologies can also be slipped in the slot in order to increase the crop yielding capacity of crops. Also , water conservation approach is seen to be the requirement as at present, they are dependent on the rainy season for farming the crops which requires lot of water like wheat. The approaches are classified into five distinct methods which are as follows:

- Proper allocation of land
- Drip Irrigation system with gravity flow
- Solar Pumps
- Grey water utilization individually for kitchen garden

### 12.4.1. Strategies in Agriculture

- **Proper land allocation for crops**

The agricultural yield is maximum if all the requirements of the crops are properly fulfilled. One of the basic requirements is the amount of sun required by the crops. Various crops require various intensities and duration of sunlight. Proper management of the sunlight can be done with proper land allocation. In Dhoksan, the settlements are in northen slope of hill which does not get maximum amount of sunlight throughout the year. Thus the crops which require less intensity of sunlight and of shorter hours of sunlight are seen to be predominant such as potatoes and maize. Thus, the allocation of lands which obtains sunlight throughout the year is proposed to produce crops which requires more sun and the crops which does not require more sunlight is proposed to be places in areas which obtains lesser sunlight.

- **Drip Irrigation with gravity irrigation**

It may be because the paddy requires floody land where the water is abundance. Local people have tradition of harvesting the stream water for rice cultivation. Also it should be noted that the Ghatte khole itself is not the river but a stream which is fed by rainwater of Dhoksan area. Whole Dhoksan area serves as catchment area and Ghatte khola acts as stream and people use that water for rice cultivation. Likewise, rice requires 6-8 sunhours for 40 consecutive days from plantation. This implies that the sunlight is also maximum at that place. The paddy field is the major source for generating food for the people; therefore, it is not only preserved but also extended to the possible fields which is irrigated by the newly proposed swale. Thus, strategies are proposed which can retain the rain water even after the rainy seasons are proposed such as creating earthen bunds which will hold water after the rainy season.

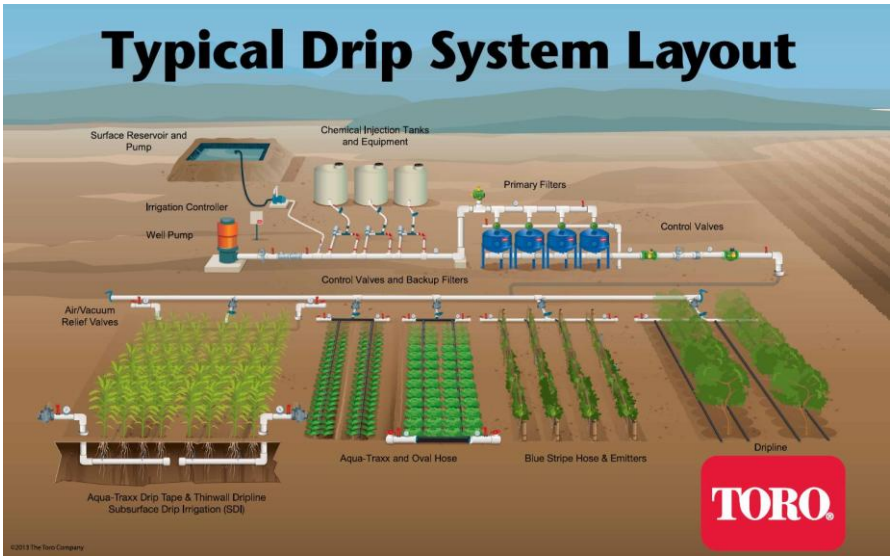



*Figure 44: Typical Drip System Layout, Source: (NETAFIM, 2015)*

Drip irrigation is not a new method; primitive drip irrigation was used in ancient China. This practice is mostly seen in small scale farming operations, the drip method localizes water to the base or roots of the plant. This system doesn't require land to be leveled for irrigation, recycled non-potable water can be used on crops safely, fewer weeds grow, and labor is less intensive versus other watering methods (Michelle, 2015). But, proper maintenance has to be carried out on regular basis since there is a possibility of clogging the pipes. Drip system is although a clear winner of agriculture since liquid fertilizers can directly be fed from the pipes which are evenly distributed, consumes less amount of water up to 35-55% and enhances crop's productivity by 40% (specifically for corn) (NETAFIM, 2015).

**Case 1**:

Though the idea of drip system is new for Nepal but the drip system has been in practice even here. The MaHafarm in Jitpur-Phedi uses, for the first time in Nepal, an irrigation system that increases productivity, allowing more harvests per year: the drip irrigation system, which was previously unknown in Nepal (Suykerbuyk, 2012). A co-operative of twelve Nepali farmers started the farm a year and a half ago, after working for six years in Israel. Additionally, the farm grows cauliflower, green vegetables, pumpkin and all vegetable harvests have improved with the system and are earning profit from the drip system of irrigation.

**Case 2:**

In Dhoksan, the prominent crop that grows is maize and potatoes. From the literature, it is found out that not only the productivity of the crop increases but the water consumption reduces drastically. By applying Drip System in maize field, the owner gained good amount of profit in

Warangal, India. The profit also can be cached in Dhoksan since it has Maize as their one of the most production crop.

**Process of DIP Irrigation to Maize**

- Irrigation once in 2 days
- Irrigation based on climatological approach

$$\text{Irrigation volume} = Pe \times Kp \times Kc \times A \times Wp - Re$$

- Pe – Pan evaporation rate (mm/day)
- Kp – Pan co-efficient (0.75 to 0.80)
- Kc – Crop co-efficient (0.4 – Vegetative stage; 0.75 – Flowering stage; 1.05 – Grain formation stage)
- A – Area (75 x 30 cm)
- Wp – Wetted percentage (80% for maize)
- Re – Effective rainfall (mm)

$$\text{Irrigation duration} = \frac{\text{Water requirement per plant once in 2 days}}{\text{No. of dripper / plant x Discharge rate (lph)}}$$

Source: (Irrigation Management :: Maize, 2013)

*Figure 45: Drip Irrigation in Wheat, Source: (Michelle, 2015)*

*Figure 46: Drip Irrigation in Maize, Source: (NETAFIM, 2015)*

**Process of drip irrigation in Dhoksan**

There is water scarcity in Dhoksan which can be reflected by the fact that they depend on rain water for farming. Drip irrigation can be prove to be a boon in Dhoksan. The time span in which they irrigate by *Perma System* is only extended up to the rainy season and by drip irrigation, the time months for irrigation can be prolonged by utilizing the available water much more efficiently as compared to now. Also, there has been the Maize production in majority scale and literature suggests that the productivity if Maize can be increased up to 40% whereby the water conservation can be done up to 35-55 %. The wheat paddy field can also use drip irrigation system to enhance the productivity and reduce water consumption. Even if it has some very useful and promising advantages but the high initial cost and unavailability of the materials required can be proved to be hurdle in realizing the drip irrigation as a promising solution to the existing issue in Dhoksan.

A particular area of Dhoksan is considered for the layout of drip irrigation. The slope area adjacent to Pakhrin Tole to the North is taken as a sample for detailing out for drip irrigation. Since the area is in terrain with contour difference of 10m, the gravity flow is taken as the best way to flow the water in the pipes of drip system. Energy is thereby conserved to make the water flow in the pipes. This system can be best option for Dhoksan but for further realization, the subsidy from the government should be initiated so that the initial cost for drip irrigation can be covered up and make it easily available and affordable by the local people to get maximum benefit from the system.

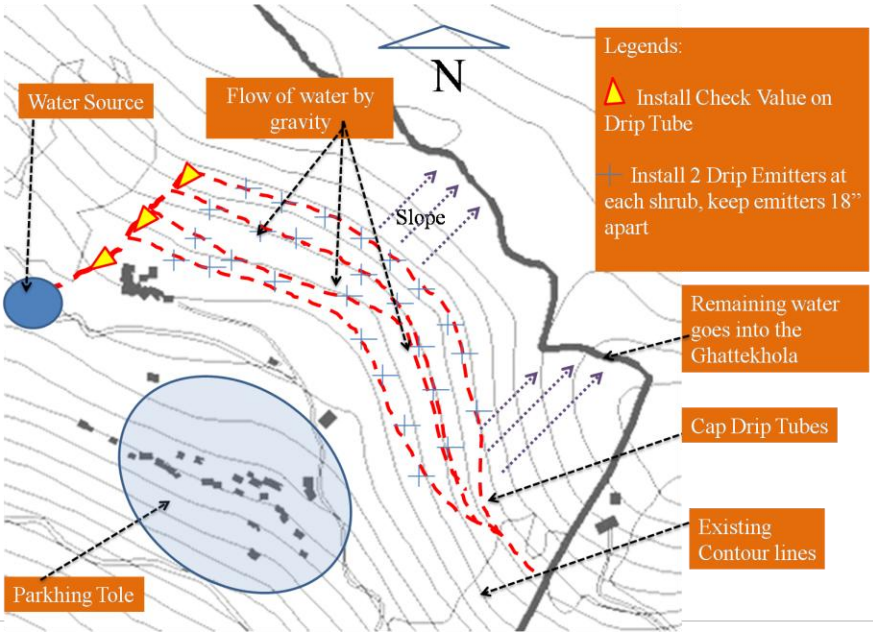



*Figure 47: Drip System for Dhoksan*

- **Solar pumps**

Subsidy for solar pumps could accelerate the use of solar pump. The government has the schemens for subsidy for solar PV cells of 70% and thus, in future there will be possibility of increasing the use of solar pumps. The solar pump has initial cost higher than that of treadle pump. A treadle pump is a human-powered suction pump that sits on top of a well and is used for irrigation. It is designed to lift water from a depth of seven metres or less.The economically weaker people can also consider treadle pump as well. The water table below the Dhoksan can be determining factor for using treadle pump.

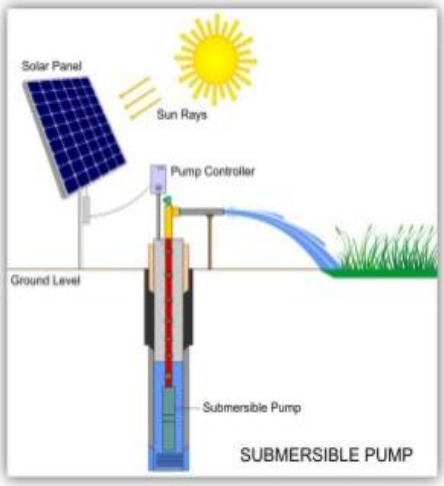



*Figure 48: Submersible Solar Pump, Source: Headway Solar P.ltd.*

The slope land of Dhoksan can be utilized for trapping energy at various levels. Gravity flow can be taken in favor while proposing the strategies. The reservoirs proposed at various height will store the rain water in rainy season. In other seasons, the reservoir can be filled with submermisble solar pump and so the irrigation process will not get hindered. The drip irrigation also adds to the efficiency of the irrigation.

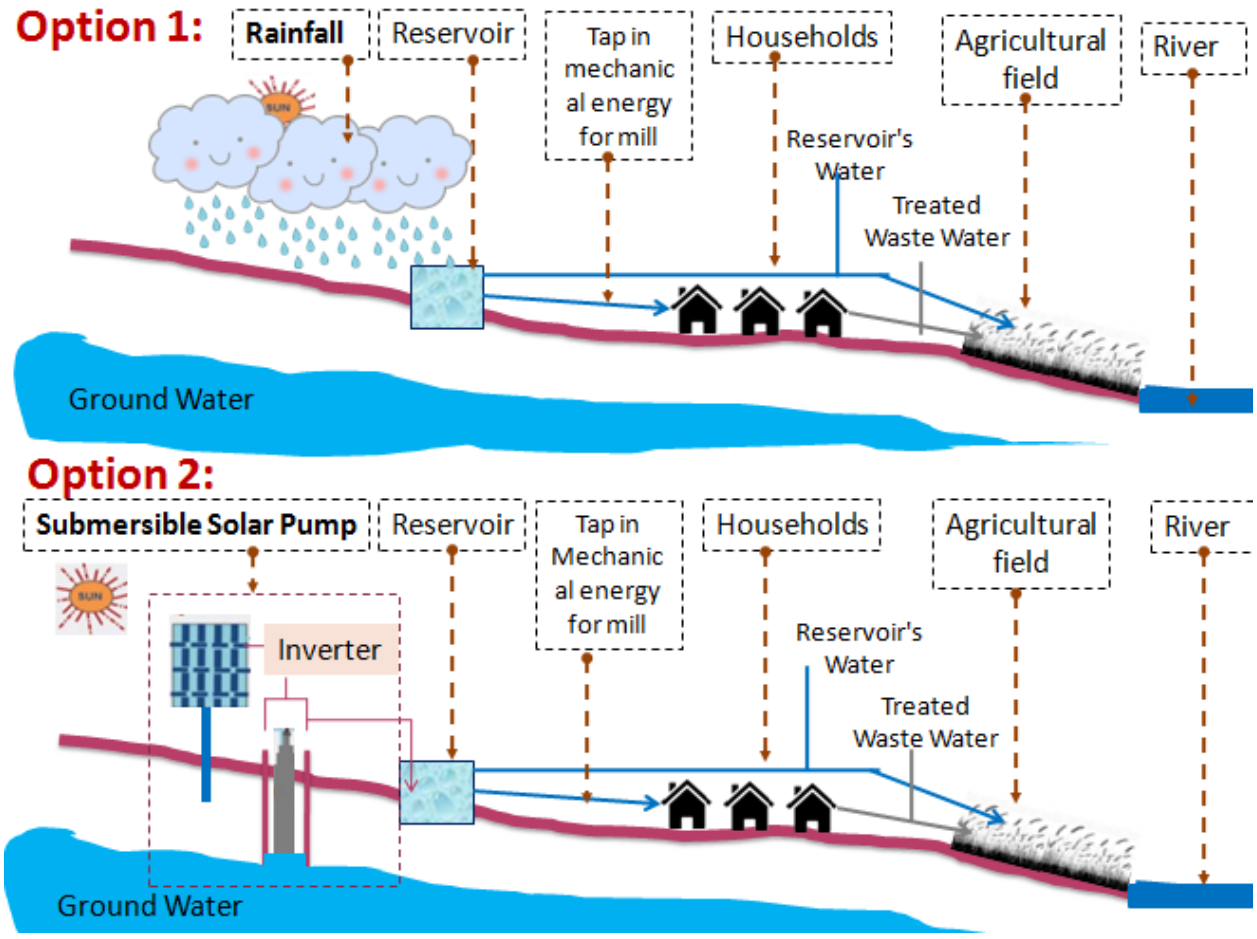



*Figure 49: Cycle of water in Dhoksan*

- **Grey water utilization**

Greywater reuse is a promising strategy in terms of the significant local water, energy, and cost savings that it can produce. However, there are also a variety of challenges to the increased use of greywater in homes, farms, and businesses. Currently, these challenges have hampered broad implementation of greywater reuse. Below, we outline several strategies for overcoming some of the most critical challenges to wider use of greywater.

A study of greywater use for irrigation in the Middle East took place in southern Jordan between February 2004 and October 2007. According to the study, "Two simple and low-cost greywater treatment units – the four barrel and the confined trench type – were installed in 110 low-income households not served by a sewerage network. The resulting greywater was used to irrigate crops that are not eaten raw. The quality of treated greywater obtained by these units was shown to be

in accordance with both Jordanian and WHO [World Health Organization] guidelines for the use of treated wastewater" (Bino et al. 2010).

A survey of a sample of program participants was done to assess the costs and benefits of the greywater systems that were implemented. Overall economic benefits were significant, with an average benefit to cost ratio of 5.3 to 1. Some cost-savings were the result of lower water costs; on average, families lowered their total water use by 15%.

**Grey water use in Dhoksan:**

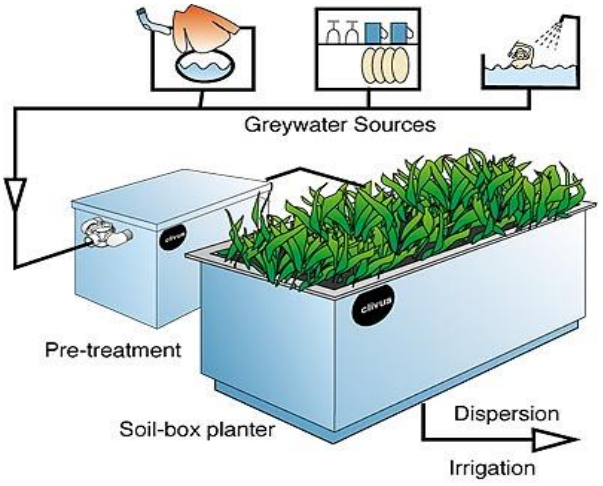



*Figure 50: Re-use of Grey Water, Source: www.greywater.com*

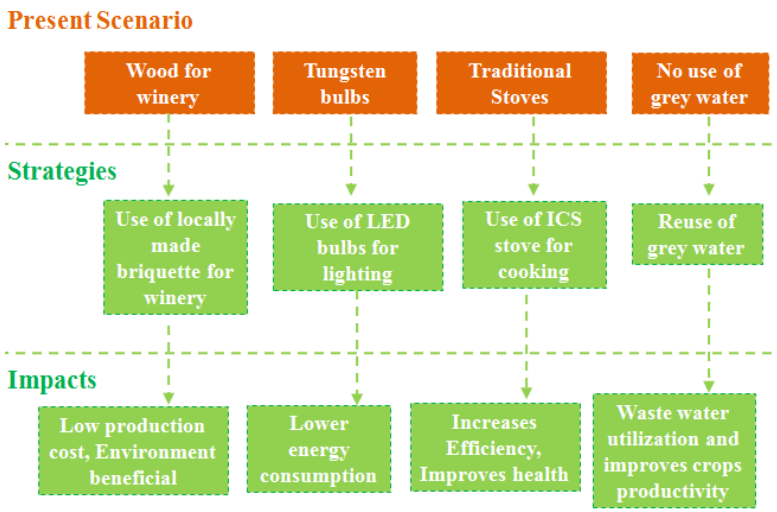
The water scarcity is seen as one of the issues faced by the people of Dhoksan. Apart from the rainy season, the area does not have enough water for agriculture and growing crops. As a key strategy that reduces demand, greywater reuse is an important strategy in improving the resilience of water systems to the impacts of climate change. In addition, greywater reuse can also be considered a relatively secure or drought resistant source of water supply because presumably greywater generated from showers and washing machines will continue, if at a reduced rate, in the future. Reuse of greywater can help displace demand for water, thus reducing conflicts over water and reducing the demand for new water supply projects. The reuse of grey water after certain level of treatment is seen to be feasible in the Baari of each household. With an average family size of 5, approximately 200 litres of daily water demand is calculated amongst which 70% of the water is accumulated in the forn of grey water which is 140 litres per day. If this amount is kept separated from the blackwater containing high amount of Nitrogen, it is way easier to treat grey water since nitrogen content of grey water is just one tenth as compared to the black water. Also, we the greywater and blackwater is separated, the amount which needs heavy treatment will be reduced since grey water can be treated very easily within box at household levels as half of the nitrogen content is on the form of organnic nitrogen which is filtered easily. Complementary to this, it also has an advantage of increasing crop's productivity as it contains nutrients richer than pure water.

## 12.5. Energy planning in Behaviour

Energy conservation can be heavily manipulated by the behavior of the people. The activities of people determine to what extent the energy can be conserved. The energy can be saved by using the efficient appliances, lighting fixtures and replacing all the things which consumes high energy without compromising in the standard of living. The smart way of living should be practiced.

**Energy Planning in Behavior of people, Dhoksan**

In Dhoksan, one of the family member in each household is said to be literate by one of the local who was interviewed. However, concern regarding energy efficient practices was seen to be missing. Furthermore, the economic standard of the people might also be a constraint in applying those approaches in practice. The present scenarios of household activities were analyzed and then the feasible strategies were proposed and then the impacts were assessed.




### 12.5.1. Strategies for energy planning in Behaviour

- **Use of locally made briquette for winery**

Winery is the dominant income generating source in Dhoksan. Many women were seen to be practicing wine making in their homes. They use woods for ignition at present. This system is proposed to replace with the briquettes which are to be produced locally. The available sources for briquettes might be leaves of trees which are in abundance. They are pressed and made compact. This proposal has parallel benefits for environmental protection.

- **Use of LED light**

Use of tungsten bulb was seen to in practice which should be replaced by the LED lights.

- **Use of ICS**

*Figure 51: Wine making by a local*

They were seen to be using traditional chulo with wood as burning fuel. However, some of them were also witnessed also to be using LPG gas. The proposition of Improved Cooking Stove with briquette as a burning fuel will not only increase the efficiency of chulo but also helps reduce pollution and contribute in clean environment. In parallel, the health of the users can also be maintained.

*Figure 52: Traditional Cooking Stove*

**Improved Water Mill**

The reservoirs are placed for the storage of water. When the water gets distributed to the fields for irrigation then the mechanical energy is proposed to be trapped and thus can be used for grinding, power generation and hollering at the same time. There are requirements for the improved water mill which are all possible in the case of Dhoksan which are as follows:

| Requirements | Availability in Dhoksan (Ye/No) |
|---|---|
| Head = more than 20m | Yes |
| Discharge = 20-100 l/s (20l/s available) | Yes |
| Speed = 200-250 r.p.m. | Yes |

Thus, a improved water mill is porposed. Also, there is a subsidy of Rs. 34,000 for Improved Water Mill (IWM) by AEPC.

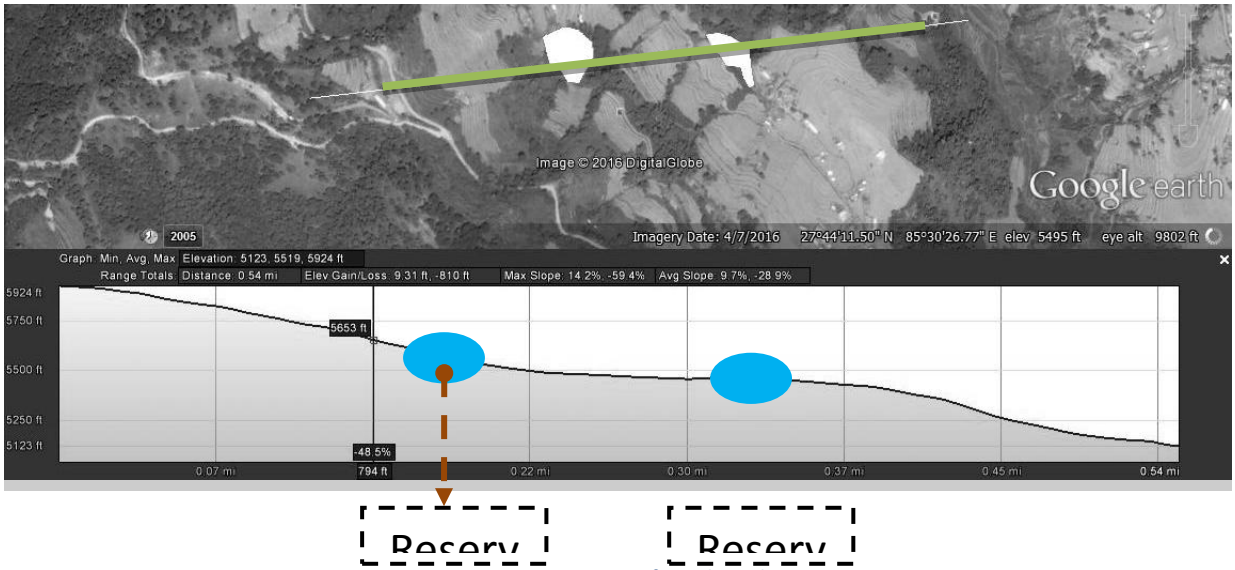



*Figure 53: Section of Northen Slope*

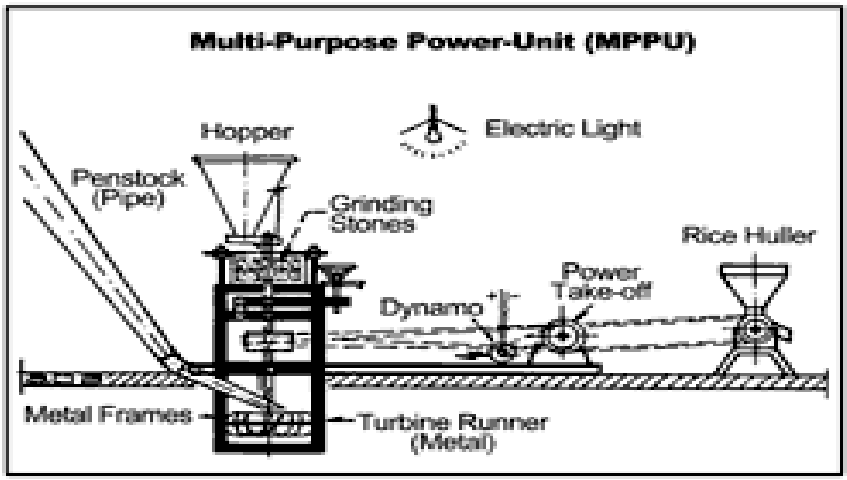



*Figure 54: Improved Water Mill*

The mill will run from the forced water flow from the proposed water reservoir. The kinetic energy from water flow is converted into mechanical energy by the turbine. The hollering machine and the husking machine are coupled with the turbine. Similarly, the kinetic energy is further used to tap electricity which can generate from 3kw- 5kw depending on the use of the

grinders. The electricity thus generated will be used for lighting the nodes and junction of the settlement.

## 12.6. Impacts

Positive impacts can be drawn from incorporating these strategies of energy conservation and energy saving in the construction of buildings. The major impacts are:

- Reduces energy for space heating.
- Reduces the energy consumption with materials with low embodied energy.
- Promotes the use of eco-friendly materials without compromising the strength.
- Promotes the utilization of locally available materials and labor which has co-benefit of cost effectiveness as well.
- Affordability in construction.
- Capacity building of local people providing employment opportunities.
- Saves water used for irrigation
- Use of clean energy in pumping (Solar Energy)
- Increases crop per drop
- Increases efficiency (in the case of Improves Water Mill and Improved Cooking Stove)
- Environmental Benefits
- Health Benefits

# 13. EXPECTED OUTPUT

For the development of a village like Dhoksan, it is needed to utilize potential of available natural resources in economic generating activities. The identity of a village is sustained by the extensive agriculture. Also, particularly Dhoksan has a high potential of tourism. The future plan for reconstruction focuses on agro-tourism which is enhanced by energy integrated infrastructure and services.

An economic prosperity shall be achieved by proper energy management making the village self-sustained in its energy requirement. By employing existing but well proven energy conversion techniques, the available natural resources can be used for various energy requirements for basic needs like electricity, agro processing, cooking, etc.

The reconstruction of earthquake damaged village shall not only be limited in immediate reconstruction but shall be utilized as an opportunity to build self-reliant village. The basic framework for Dhoksan reconstruction as mentioned in this report may not be sufficient but shall act as a guiding direction for retaining rural character. This report assures that essence of Dhoksan as a village shall remain as an village but with advanced energy services and infrastructure for quality life. Through a well analyzed reconstruction proposal, a basic outline for upliftment of Dhoksan village from its grass root level to a more sustainable and resilient community can be traced.

# 14. FURTHER ACTIVITIES AND RECOMMENDATIONS

For furthering the intended activities, proposed programs and desired interventions, it is necessary for the community to prepare plans. Context specific planning is highly revered when it is accepted and worked out by community participation and proper allocation of resources. We have prepared recommendations on headings from our set goals, which will target for furthering and meeting strategic objectives.

## 14.1. Economic sustainability:

- Value added agricultural practices
    - Addition of value to agricultural produce

        - Distribution and Promotion strategies
    - Building social capital for increased economic opportunities
        - Increasing social linkage by engaging in opportunities for income generation
        - Community representing local bodies
        - Establishing chain of linkage for furthering activities implementation
    - Cost-benefit analysis
        - Accessing pay back (investment return) for activities
        - Preparing plans for community shared benefits, and capacity building
    - Community capacity building by prioritizing local-participatory activities
    - Accessing for least environmental impact while designing of activity

## 14.2. Environment sustainability:

- New development should be harmonious with nature
- Energy and environment sensitive Infrastructure development
- Building and improvement of existing tracks
- Reconstruction process
- Building complying with natural setting
- Promoting indigenous resources and locally available materials
- Prioritizing building materials with low embodied energy
- Preferring reconstruction on existing building footprints
- Regulating new constructions based on densifying along existing settlement
- Implementation of constraints on maximum number of occupants in the settlement
- Procurement process of building materials from local resources
    - Soil (if compact stabilized soil earth block, sundried brick, mortar)
    - Timber (from nearby forest, afforestation programs)
- Community deployed regulation
    - Forest Preservation and afforestation programs
    - Preserving and working with nature, ensuring healthy natural cycle

## 14.3. Social sustainability:

- Improved livelihood with continuation of social and cultural practices
    - Agricultural productivity increment
    - Value addition to agriculture
- Ameliorate culture with changing practices
- Increasing social capital

- Social and community representative bodies
  - Active involvement in development, design and delivery activities
  - Increased sense of ownership
- Community decision making practices
- Make use of existing linkages to further improved livelihood
- Community group's Collaboration

### 14.4. Energy sensitive planning:

- Energy for household
  - Make effort for improving electricity capacity
- Energy for other activities
  - Upgrading from two-phase to three-phase (for workability of electric equipment)
  - Planning process involving energy conservation strategies.
  - Using energy efficient technologies
- Energy for reconstruction
  - Building material with low embodied energy
- Energy for agriculture
  - Water for irrigation fed from gravity
  - Agro processing form RET
- Indentifying and familiarizing with procedures for available subsidies from various institutions for energy efficient systems and RET

# Works Cited


1. (n.d.). Retrieved from http://nawadurga.blogspot.com/2009/08/about-of-muktinath-temple.html.
2. A.D., B. (1999). *Economic, social, and environmental sustainability in development theory and urban planning practice.* Boston: Kluwer Academic Publishers.
3. Akansha Gupta, A. S. (2016). *A Report on Sustainable Design for Social Development of Ranipauwa.*
4. Akansha Gupta, P. T. (2016, 05 04). Conterxt bulding on Ranipauwa and Thermal Comfort. (D. B. Chhempel Gurung, Interviewer)
5. Akansha Gupta, P. T. (2016, 05 05). Context building on Ranipauwa and Thermal Comfort. (R. o. Govinda Acharya, Interviewer)
6. Akansha Gupta, P. T. (2016, 05 06). Context building on Ranipauwa and Thermal Comfort. (T. D. Gurung, Interviewer)
7. Auroville Earth Institute. (n.d.). *Compressed Stabilised Earth Block*. Retrieved 06 08, 2016, from Auroville Earth Institute: http://www.earth-auroville.com/compressed_stabilised_earth_block_en.php
8. Bibeksheel, N. (2014, june 2). Retrieved from https://www.youtube.com/watch?v=MlYpsNCAGXY
9. CEPAD. (2011). *DISTRICT CLIMATE AND ENERGY PLAN - MUSTANG DISTRICT.* Lalitpur, Nepal.
10. FAO. (2015). *Conservation Agriculture.* FAO.
11. *Flora of Nepal*. (2016, March 15). Retrieved from wikipedia: https://en.wikipedia.org/wiki/Nepalese_Broom_Grass_(Thysanolaena_Maxima)
12. Gellings, C. W. *Energy Efficieny in Agricultiral Equipment.*
13. Govinda, K., Karki, T. B., Shrestha, J., & Achhami, B. B. (2015). Status and prospects of maize research in Nepal. *Journal of Maize Research and Development* , 1(1):1-9.
14. Gurung, C. P. (1993). Conservation for Sustainable Development: Myth or Reality? A Case of the Annapurna Conservation Area Project, Nepal,. *Himalaya, the Journal of the Association for Nepal and Himalayan Studies , 13* (1), 31-38.
15. *How To Insulate Your Brick Wall Cavity*. (2015, 03 27). Retrieved 04 26, 2016, from about home: http://homerenovations.about.com/od/heatingandcooling/a/CavityInsulation.htm
16. IFAD. (n.d.). *ruralpovertyportal.org*. Retrieved from http://www.ruralpovertyportal.org/country/voice/tags/malawi/malawi_foodsecurity
17. *Individual Home Sewage Treatment Systems (AE892 (Revised))*. (2015, 10). Retrieved 06 22, 2016, from NDSU Publications: https://www.ag.ndsu.edu/publications/home-farm/individual-home-sewage-treatment-systems#section-13

18. *Informarion about Rammed Earth*. (n.d.). Retrieved from Rammed Earth Constructions: http://www.rammedearthconstructions.com.au/rammed-earth-info/

19. *Irrigation Management :: Maize*. (2013). Retrieved 06 13, 2016, from TNAU AgriTech Portal: http://agritech.tnau.ac.in/agriculture/agri_irrigationmgt_maize.html

20. Kokemuller, J. (n.d.). *HOME GUIDES*. Retrieved from SFGATE: http://homeguides.sfgate.com/need-lot-light-grow-rice-86981.html

21. Lucy Allen, J. C.-S. (2010). *Overview of Greywater Reuse : The Potencial of Greywater Systems to Aid Sustainable Water Management.* Pacific Institute.

22. *Make a simple Solar Air heater*. (2014, 09 24). Retrieved 04 05, 2016, from REUK.co.uk - The Renewable Energy Website: http://www.reuk.co.uk/Make-a-Simple-Solar-Air-Heater.htm

23. Mazumdar, N. B. (2012). *Nepal: Capacity Building for Waste Management.* ADB.

24. Michelle. (2015, 04 04). *Drip Irrigation : Saving Water*. Retrieved 06 17, 2016, from Great Basin Grown: https://greatbasingrown.wordpress.com/2015/04/04/drip-irrigation-saving-water/

25. Milne, G. (2013). *Embodied Energy*. Retrieved 06 17, 2016, from Your Home, Australian guide to environmentakky sustainable homes: http://www.yourhome.gov.au/materials/embodied-energy

26. Ministry of Culture, Tourism & Civil Aviation . (2014). *NEPAL TOURISM STATISTICS 2014* . Ministry of Culture, Tourism & Civil Aviation , Planning & Evaluation Division . Kathmandu: Ministry of Culture, Tourism & Civil Aviation .

27. Mishra, B. (2012, february 4). *COMMON FODDER AND FORAGE CROPS OF NEPAL*. Retrieved from worldpress: https://bijeshmishra.wordpress.com/tag/bakaino/

28. NETAFIM. (2015, 02 24). *Increases of up to 40% in corn yield in India show the value of correct design, planning and management of drip systems*. Retrieved 06 18, 2016, from Pioneering Irrigation by : http://blog.netafim.com/increases-of-up-to-40-in-corn-yield-in-india-show-the-value-of-correct-design-planning-and-management-of-drip-systems/

29. Parajuli, A. (2015, June 25). *Cultivated, Wild and Poisonous Mushroom Species Found in Nepal*. Retrieved from parajulianis.wordpress.com: https://parajulianish.wordpress.com/2015/06/25/cultivable-wild-and-poisonous-mushroom-in-nepal/

30. parajulianish. (2015, June 25). *AGRARIAN BLOG*. Retrieved from worldpress: https://parajulianish.wordpress.com/2015/06/25/cultivable-wild-and-poisonous-mushroom-in-nepal/

31. Parakh, A. B. (2008). *Life cycle approach to green building, Strategic focus for CO2 emissions reduction in buildings for the urbanization decade 2009-2019, The VSBK/CESEF programme: Nepal.*

32. polyframe. (n.d.). *Double Glazed Windows By Polyframe*. Retrieved 04 02, 2016, from Polyframe: http://www.doubleglazedwindowsaustralia.com/

33. Samuel, R. (2011, February 8). *Kuntz, a multipurpose plant*. Retrieved from agriculturesnetwerk.org: http://www.agriculturesnetwork.org/magazines/global/forging-partnerships/kuntz-a-multipurpose-plant

34. Scivye, M. J. (2009). *A practical guide to building airtight dwellong.*

35. Shrestha, K. K., Sanjyal, S., KC, P., & Kandel, R. (2007). *animal breeding division*. Retrieved from www.narc.gov.np: http://narc.gov.np/org/pasture_fodder.php

36. *SUCCESS STORY OF MAIZE CROP UNDER DRIP IRRIGATION*. (n.d.). Retrieved from eFresh, Empowering Agriculture: http://efreshglobal.com/eFresh/Content/free.aspx?u=microirrigation_maize

37. Suykerbuyk, L. (2012, 05 04). *MAHA FARM World Class Work*. Retrieved 06 15, 2016, from Spotlight, News Magazine: http://www.spotlightnepal.com/News/Article/MAHA-FARM-World-Class-Work-

38. Torodriptips. (2013, 09 19). *Drip Tips*. Retrieved 06 19, 2016, from Subsurface Drip Irrigation (SDI): http://driptips.toro.com/subsurface-drip-irrigation-sdi/

39. Vajiyan, B. (2014, April 4). Retrieved from youtube: https://www.youtube.com/watch?v=ePv3tVstlh8

40. Vincentius Totk Noerwasito, R. N. (2014). *Embodied energy efficient in the composition of bamboo walls and soil blocks walls.*

41. Vincentius Totok Noerwasito, R. N. (2014). *Embodied energy efficient in the composition of bamboo walls and soil block walls.* ScienceDirect.

42. Viney, D. (2004, December 18). *4931 - Stakeholder Analysis and Stakeholder Management*. Retrieved April 2, 2016, from Stakeholder Analysis and Stakeholder Management: http://www.tooboring.com/ph_Stakeholder--Analysis--and--Stakeholder--Management_computers.php

43. WaterAid. (2008). *Ecological sanitation latrines:The experience of Nepal.*

44. Wikipedia. (2016). Retrieved from https://en.wikipedia.org/wiki/Vermicompost

45. Wikipedia. (2016). *Ranipauwa*. Retrieved 04 25, 2016, from Ranipauwa: https://en.wikipedia.org/wiki/Ranipauwa

46. Wikipedia. (2016). *Upper Mustang*. Retrieved March 31, 2016, from Upper Mustang: https://en.wikipedia.org/wiki/Upper_Mustang

47. Zucker, D. M. (2009). *How to do case study research.* University of Massachusetts.