

IMMEDIATE RECOVERY VISION FOR GEO-INFORMATION SECTOR IN THE CONTEXT OF POST 2015 EARTHQUAKE RECONSTRUCTION

Krishana Raj B.C., Director General, Survey Department,
Ganesh Prasad Bhatta, Deputy Director General, Survey Department,
Suresh Man Shrestha, Deputy Director General, Survey Department,
Niraj Manandhar, Division Chief, Survey Department,
Anil Marasini, Chief Survey Officer, Survey Department

Keywords: Earthquake, CORS, Geodetic Network, Rehabilitation, Orthophoto Image, DTM

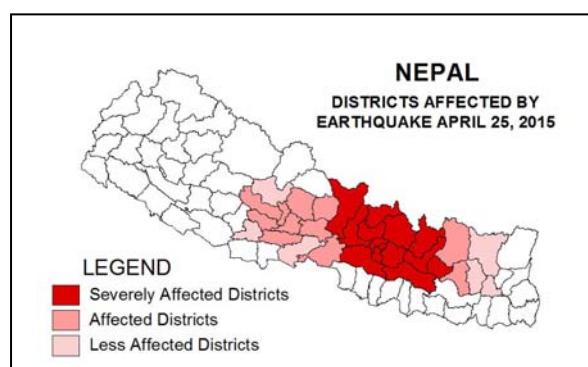
Abstract: The devastating Earthquake - 2015 has not only caused heavy loss of human lives and properties but also destructed the base of surveying and mapping. Maps and geo-information are the foundation for resettlement and development activities whereas Geodetic Control Network is the fundamental base for all kind of mapping activities. Accurate and reliable Geo-information is the foundation for any Post Disaster planning, resettlement activities, Disaster Risk Reduction and all kind of development activities. The Geodetic Network is the infrastructure of the infrastructures. For any development activities, mapping is a must and that the mapping to be of sufficient accuracy, the accuracy of Geodetic Network must be ascertained. Every developmental activities, reconstruction, rehabilitation, reconciliation processes require geo-information and other census data. Successful implementation of this programme will ensure the reduction in data redundancy and ultimately reduces the time and cost for geo spatial data production.

1 BACKGROUND

The devastating earthquake of April 25, 2015 and a series of aftershocks have not only caused heavy loss of human lives and properties but also destructed the base of surveying and mapping or geo-information. The main reason behind the destruction is the shift of the earth mass in the earthquake affected region, which disturbed the geodetic control network, which is the fundamental base for surveying and mapping activities. The preliminary results from the study undertaken by Survey Department, soon after the April 25 earthquake, showed that the Kathmandu valley has been shifted by 1.8 m, in average, southwestwards and raised up nearly a meter in ellipsoidal elevation. This shift in the land mass of the region shows that there has been considerable disturbances in the geodetic control network, which is passive in nature, in the earthquake affected region affecting its connection with the entire national network. Such disturbances in the geodetic control network necessitated its rehabilitation before carrying out future activities of surveying and mapping or geo-information production in order to acquire required accuracy. At the same time, in absence of accurate geodetic network, mega projects of national importance such as hydropower, irrigation, among others, will be greatly affected.

The reconstruction effort will need a large scale maps and relevant geoinformation products in the region to carryout overall planning of the reconstruction and rehabilitation. Land resource maps will be required to

ensure the resettlement of disaster prone villages to safer location and formulating village level land use plans. In the same way, the property boundaries have to be rehabilitated after the devastation. So, exiting cadastral maps have to be spatially corrected in order to accurately delineate the parcel boundaries.

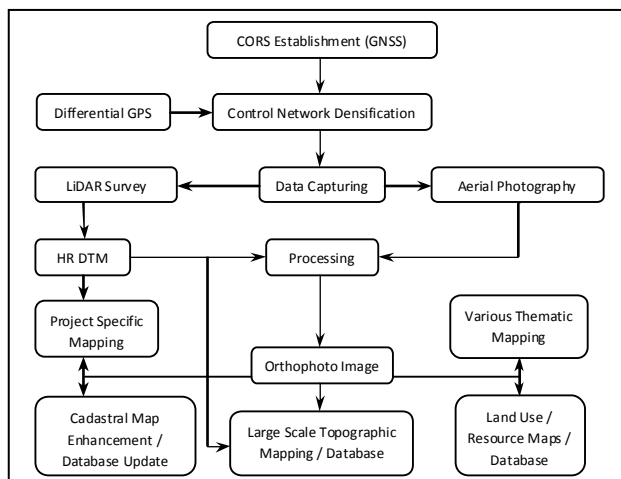


Thus, there are various geoinformation related needs and depending upon the availability of resources priority has to be set to begin with, especially to support ongoing reconstruction efforts of the government in the region. Survey Department, under the Ministry of Land Reform and Management, being National Mapping Organization of the country, as per its mandate, has to bear this responsibility. In this context, this 'Strategic Recovery Vision' has been proposed based on the overall vision of the Department for the future activities.

2 FUTURE VISION OF SURVEY DEPARTMENT

With the dramatic evolution in the sector of Geo-information and communication technologies, spatial enablement of the society is growing rapidly. Emerging technologies have provided opportunities for making use of geoinformation not only for the projects of infrastructure development but also every sector of human society including planning and policy making. Therefore, in order to meet the changing needs of the society, Survey Department has to shift from its traditional way of producing supply driven products to demand driven ones. Being National Mapping Organization of the country, the department has to focus on the base data that can support the production of other geoinformation for specific purposes.

In this context, Survey Department has envisioned that its future activities will be based on the most modern technologies and methodologies. Workflow of the envisioned multipurpose mapping project is as follows.



Workflow of the envisioned integrated multipurpose mapping project of Survey Department

Main concept of this project, in brief, is that a dynamic geodetic datum is defined based on Continuously Operating Reference Stations (CORS) established throughout the country. Existing geodetic control network is rehabilitated and strengthened based on the newly defined dynamic datum. Newly defined dynamic datum and rehabilitated passive datum both are used for mapping activities of the future. Precise levelling will also be carried out as required.

Similarly, aerial photography along with LiDAR survey is carried out to produce high resolution digital terrain model (DTM). Orthophotomaps are produced based upon the aerial photographs and the DTM. The orthophotomaps and DTM are further processed for producing various kinds of geoinformation products including updating existing National Topographic Database, producing new series of Topographic Maps in larger scale; 1:10,000, updating land resource maps,

producing maps of different thematic areas, enhancing spatial accuracy of cadastral maps among others.

3 RECOVERY STRATEGY IN THE CONTEXT OF POST 2015 EARTHQUAKE

3.1 Setting Priority

As mentioned in the Background Section, there is a need of multiple geoinformation products in order to facilitate ongoing efforts of reconstruction. However, availability of resources and organizational capacity may not be in favor to take all the needs at a time. Therefore, setting priority is important, and criteria for the recovery programs have been judged on the basis of need assessment for the reconstruction process as well as the long term stability of the products resulted from the implementation programs. Based upon the judgment, the Department has prioritized as follows:

3.1.1 Establishment of Continuously Operating Reference Stations (CORS) & Rehabilitation of Geodetic Network

The geodetic network is considered to be the infrastructure of infrastructures, as without it no mapping activities, which are fundamental infrastructure for developmental activities, are possible. For any development activities, mapping is a must and that the mapping be of sufficient accuracy, the accuracy of geodetic network must be ascertained. Since the April 25 Earthquake and series of following



CORS Station

aftershocks have damaged the existing geodetic network, it is high time that we rehabilitate the damaged network. This is why the establishment of CORS including the rehabilitation of existing network has been on priority.

3.1.2 Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map

Similarly, every developmental activities, reconstruction, rehabilitation, reconciliation processes require various kinds of geo-information along with other data. Accurate and reliable Geoinformation is the foundation for any Post Disaster planning,

S.N.	Programs	Results	Indicators	Application Areas
1	Establishment of CORS & Rehabilitation of Geodetic Network	Rehabilitated and Strengthened Geodetic Network	<ul style="list-style-type: none"> About 150 CORS established throughout the country Geodetic Control Points of different orders rehabilitated Geodetic Datum updated Real time GNSS solutions commenced 	<ul style="list-style-type: none"> Geodetic Studies including deformation studies National Mapping Activities Mines and Geology Hydropower Development Activities Academia Research
2	Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map	Newly acquired and updated geo-information products	<ul style="list-style-type: none"> High resolution DTM prepared High resolution Orthophoto map prepared Feature extracted to produce various kinds of geoinformation products 	<ul style="list-style-type: none"> Updating of National Topographic Database Land Use Planning Cadastral Mapping Infrastructure Development Projects such as Hydropower, Irrigation, Roads etc. Disaster Risk Mitigation Resettlement

resettlement activities, Disaster Risk Reduction and all kind of development activities. Proper evaluation and analysis of geoinformation with socio economic data will guide to plan in organized way which lead to better disaster risk management and ultimately facilitate for good governance.

Existing geo-information provided by the Department are based on the aerial photographs of early 1990s, which are quite old to support the required need. Due to lack of update, these geo-information are currently outdated. In order to effectively plan and implement the post disaster reconstruction process, need of updated geo-information is inevitable. Hence, the

Expected Results and Indicators

programme of preparation of high resolution orthophoto and DTM has been placed in the same priority.

3.2 Implementation Strategy

3.2.1 Establishment of CORS & Rehabilitation of Geodetic Network

Establishment of CORS may require international expertise or outsourcing, whereas the rehabilitation of geodetic network and further extension of the established points is to be done with in-house expertise. Even if the establishment of CORS is done by using international expertise, there will be the involvement of competent staff in the project from the Department. This will help in building the capacity to own and operate the CORS Network and after the successful completion of the project, there will be a number of competent staff for the rehabilitation of the geodetic network. In the first phase, the project will be concentrated in the earthquake affected areas, and can be extended beyond the region as per the availability of required resources.

The data from the CORS has to be processed for the accurate positioning of control points and these data are also useful for other sectors such as Department of Mines and Geology (DoMG) for seismological studies, sectors requiring locational information, sectors working in the field of rescue operation and different

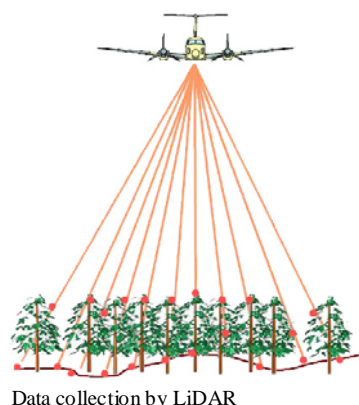
navigational purposes. Recent studies on GNSS has shown that the data from CORS are equally useful to predict upcoming earthquakes to some extent. Therefore, establishment of CORS will further contribute in societal benefits.

3.2.2 Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map

Production of high resolution DTM and Orthophoto map may also require outsourcing or international expertise, as the aerial survey as well as LiDAR survey are beyond the capacity of the Department. However, there will be the involvement of competent staff in the program. This will help in building the capacity to own

and operate the above mentioned products. This capacity can be utilized to derive various other geo-information products such as topographic base maps and several thematic maps.

High resolution orthophoto map and Digital Terrain Model (DTM) of the earthquake affected 31 districts will be prepared through aerial photography and LIDAR surveying. Production of high resolution DTM



and Orthophoto Image could be the foundation for multipurpose mapping. As DTM provides information about elevation and rectified orthophoto shows the ground reality, combination of both will be the milestone for geospatial analysis and every kind of mapping activities like disaster response, topographical data acquisition, cadastral map enhancements, land use

planning, geological mapping and many more. Apart from these, the data will be highly useful for the mega projects of infrastructure development like hydropower, irrigation, among others. These all kind of products can be prepared with in-house capacity. The geo-information can be shared to other stakeholders which will reduce data redundancy.

3.3 Expected Results and Indicators after implementation

After the successful completion of "Establishment of CORS & Rehabilitation of Geodetic Network" programme, it is expected that the Geodetic Network of Nepal will be rehabilitated and strengthened.

Similarly, after the successful completion of "Production of high resolution Digital Terrain Model (DTM) and Orthophoto Map" programme, it is expected to have newly acquired and updated geo-information products.

More details on expected results and indicators has been presented in the table "Expected results and indicators" in previous page.

3.4 Source of Financing and Budget Estimation

Government of Nepal has considered both of the above mentioned projects of high importance and hence both are included in the Post Disaster Recovery Framework (PDRF) sector plan of the National Reconstruction Authority (NRA). This shows the full commitment from the Government to accomplish the projects, however, the source of financing has to be explored. The duration has been planned for five years and the total budget estimation is about 5,102 million NRs.

4 CONCLUSION

Devastating earthquake of April 25, 2015 and series of aftershocks irreparably damaged the geodetic control network apart from heavy losses in different sectors. It has severe impact on the overall surveying and mapping activities of the country. Recovery efforts of the Government require updated geoinformation products for effective planning and implementation of various programs and projects. Survey Department has the mandate of producing and disseminating geoinformation products of national need. However, at the current stage, the Department is not in position of providing the geoinformation of current need, as the source of the data is quite old. In this respect, newest effort is required, at least in the earthquake affected region and hence the two prioritized programs have been put forwarded. Upon successful implementation of the programs, the Department will be able to meet the current geoinformation need, which will be readily available to share with the different organizations from public and private sectors. This effort will not only support the Department to make technological shift but also help reduce redundant efforts as well as

investment for the same purpose by different organizations.