Strengthening National Geographic Services in Lao PDR

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SUMMARY

Strengthening National Geographic Services in Lao PDR is a four year programme started in August 2010. The programme is bilateral technical co-operation between the Government of Lao PDR and the Government of the Republic of Finland. The programme is continuation to extensive support from Finland to Laos, particularly focused on land sector.

The programme purpose is to assist the National Geographic Department (NGD) in creating, managing and distributing reliable modern national spatial data services to public and private stakeholders and clients. The services will include database for digital topographic maps at 1:50,000 and digital orthophoto maps covering first the project area. The programme will improve the geodetic database of Laos. It will build the NGD capacity to enlarge this database to update and develop the database according to key needs of the stakeholders and clients.

The programme approach is based on institutional development and capacity building. The technology development is closely linked with capacity building of the NDG and its partner organisations.

The mapping project area within this programme phase is southern part of the Lao PDR which includes the provinces of Savannakhet, Saravan, Champasak, Xekong, Attapu and southern part of the Khammouan province. This area covers 71,000 km², equalling to approx. 1/3 of the country and had in 2005 2.2 million inhabitants.

As result of the programme, Laos will have enhanced capacity and human and financial resources to maintain geographic information on its own. Geographic Information collected during the programme consists of digital orthophoto maps (accurate up to scale 1:5,000) and topographic maps at scale 1:50,000, both covering the project area. Geodetic network will be densified all over the country and a seamless rectified satellite image mosaic covering the whole country will be produced. This data will form the base of National Spatial Data Infrastructure and it will be used in various governmental and private organisations. Policy to share the data among various stakeholders will be established and Strategy and Mid Term Development Plan of National Geographic Department of Lao PDR will direct further development in this field.

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1. INTRODUCTION AND BACKGROUND

One of the core priorities of the government of Lao PDR continues to be the eradication of poverty, through the provision of an enabling environment for growth and development including private sector development. The government is guided in its attempts by the Millennium Development Goals, a set of targets that address many dimensions of human development, including that of halving the proportion of people living in extreme poverty by 2015.

Population of Lao PDR has grown from 4.6 million to 6.2 million during last decade, and urbanisation continues with accelerating speed. In the year 2000, 20% of the population lived in urban areas, and it is expected that by 2030 already 38% of the population will live in urban areas. In practise this means that the urban population will more than triple by 2030 leading to development of new infrastructure, dwellings, transportation systems etc. Concentrations of people in urban and suburban areas change their environment more rapidly than those on traditional rural areas and therefore also the need of up-dating geographic information is there more frequent.

The main Governmental bodies in Laos producing, distributing and utilising spatial data are the National Geographical Department (NGD) and the National Land Management Authority Department (NLMA). Both of the departments operate under the Prime Minister's Office. NGD's Mandate is based on Decree of Prime Minister No 73/PM dated September 20, 1995. National Geographic Department's authorization is "to research and establish policies regarding surveying, aerial photography and mapping for submission to the government for consideration, approval and official spread". The mandate includes among others "responsibility to study and collect user demands arising from data, equipment, manpower within the field of surveying, aerial photography and mapping in the whole country, of socio-economic and cultural sectors and making short term and long term plans for proposal to the government for official approval and implementation".

Management of the constant change is a big challenge for National Geographic Department of Lao PDR. They still have some basic data in their archives, but they haven't got means to do any re-mapping or even update the existing information. Big part of the basic data in active use exists only in paper format. The digital topographic data covering the country at scale 1:100,000 is not accurate enough and is widely based on 10-20 years old information. The digital maps of Vientiane Plain and four major towns at scale 1:5,000 are based on ten years old photography and already clearly outdated. The distribution of the existing materials is not fully efficient. Many of the potential map users are not fully aware on the availability of the

various map and data products.

Up-to-date information on geography and environment is a necessary element for planning and implementing programmes in order to eradicate poverty from the country and to manage the limited natural resources in a sustainable way. Because of the constant change, which is accelerating especially in urban and suburban areas, the information must be updated often enough. Data, which was valid for decades earlier, now becomes outdated within few years. In order to facilitate its development the Government of Lao PDR needs new basic up to date spatial information in form of digital maps and orthophotos, and means and capacity to maintain and update them after they have been acquired. In building national spatial data infrastructure accurate topographic maps and orthophotos are needed to create a common base for the spatial data.

In Lao PDR the National Geographic Department (NGD) has some recent experience, capacity, knowledge and facilities for topographical mapping and map printing. The last such activity was the Vientiane Plain Mapping project (1:5,000 scale). The project was implemented utilising the latest technology of its time (project run from 1998 to 2003). This project also included digital mapping of towns Luang Prabang, Thakhek, Savannnakhet and Pakse. Unfortunately also these maps are already getting outdated. Their distribution has not been efficient. In 2009 NGD is preparing topographic maps at scale 1:25 000 totalling 3 km on both sides of the border on the border Laos-Thailand for defining the national border.

Topographic maps from 1980's, that were still made in previous Vientiane Datum 1982 co-ordinate system, are also, at least for many parts of the country, outdated and, in any case for all of the country in outdated grid co-ordinate system. These maps were partly updated in 1998-2002 by a JICA funded project partly using aerial photography from 1998-99 and partly SPOT satellite images. The result was 1:100 000 digital topographic maps covering all of the country. No sheets of these maps were ever printed. They have been delivered to clients in colour plotter versions and in digital format. Accuracy of these maps has not been satisfactory enough for the clients and this data is becoming outdated for most densely populated provinces.

Land Information Coordination Strategy was prepared under Land Management Authority and Lao Land Titling Project II by Prof. Dan Grant in December 2006. It consists from two volumes I Executive Summary 66 p and II Framework Report, Attachments 185 p. This strategy recommended the Lao PDR Government to appoint a leading organisation to build up the spatial databases and to manage the National Spatial Data Infrastructure. The design of NSDI was proposed to be started in NGD by October 2007.

The drafted Land Information Coordination Strategy was never approved by the Lao PDR Government. It has been used partly as a guideline in the Land Management Authority but no serious implementation of the strategy and any planning for National Spatial Data Centre in NGD have ever started. The strategy clearly supports 1:50,000 digital topographic mapping and orthophoto mapping. It also gives policy and practical guidance for future steps in building up the infrastructure. Implementation of the strategy has already shown to be much

slower and more complicated than expected.

2. PROGRAMME COMPONENTS

The programme "Strengthening National Geographic Services in Lao PDR" and its implementation are fully integrated into the existing organisation of NGD and its everyday operations. For practical reason the programme is divided into three components and their sub-components which are briefly described below.

2.1 Component 1 Service Policy Development in the National Geographic Department

2.1.1 Sub-component 1.1 Long Term Strategy and Mid Term Development Plan of the National Geographic Department

In order to develop NGD and its services the organization needs an overall long term (10 years) Strategy and a midterm (5 years) Development Plan showing the way to implement the strategy. The long term strategy will be in line with the Sixth National Socio-Economic Development Plan (2006-2010) as well as the National Growth and Poverty Eradication Strategy (NGPES).

During Vientiane Plain mapping project a five year strategic plan was made for NGD covering years 2001-2005. Sub-component 1.1 includes critically evaluating, updating and extending this plan through a participatory institutional review to cover the years 2010-15. The institutional review will initially be conducted internally at NGD by conducting SWOT and human resources analysis, and establishing common understanding on the requirements and development needs of NGD. This will be followed by market and customer needs review to be done through stakeholder workshop with sub-component 1.2. The goal is that eventually NGD will have a long term strategy and midterm development plan including its future mapping and geographic data production tasks, updating, coordination of spatial data, data sharing, pricing policy and capacity building; based on continuous follow up of the needs of its key stakeholders and clients.

Mid-term strategy will be based on making sure that key stakeholders and geographical data users in Lao PDR are well aware of the data products of NGD and the availability of the data. This will be accomplished via strong awareness raising amongst the key national level clients and potential other users of the project phases through workshops, direct engagement and web publishing.

2.1.2 Sub-component 1.2 Locating clients and providing them with access to geographic data in Lao PDR

During the inception period of the programme a stakeholder and client review has been made. It includes a review of key stakeholders at national, provincial and in typical district levels, including key donors and major private clients. The information on the needs of clients will

be updated regularly throughout the programme. Marketing and information campaign covering both existing old and new geographic materials produced by the programme will be carried out according the availability of the new product items.

One of the main challenges related to geographical information in Lao PDR is the lack of communication between different organisations and government departments using geospatial data. In order to narrow this gap between NGD and the stakeholders the approach is to make the availability of the data and progress of the project visible to the other entities from the first day of the project. This is critical not only to find new users and clients, but also to avoid overlaps and duplication and to enable efficient and transparent data sharing. In addition to the public awareness rising targeted at both rural and urban population, marketing will become one part of the everyday activities of NGD.

2.2 Component 2. Technical Capacity Building of the National Geographic Department

Strengthening the capacity of NGD needs institutional development, which consists of procuring additional equipment and software to NGD and training the personnel of NGD to operate the modern equipment and software with digital photography data. The activities of this component include:

- Procurement of necessary equipment, software and materials preliminarily listed in the programme budget
- Repairs and maintenance of existing equipment, software and IT into operational condition when applicable
- Establishment of a modern digital orthophoto production and digital mapping line
- Provision of a digital small format or medium format aerial photography equipment and processing programs
- Updating staff training schemes and related human resource management practices to cope with new skill requirements, changes in organisation and the staff turnover
- Training course for small-format aerial imaging and data processing including on the job training
- On the job training for the use of digital stereo plotters
- On the job training on geodesy, surveying, mapping, GIS and IT
- On the job training in client services, marketing and analysing the client feedback
- Preparation of necessary working manuals in Lao and English languages.

2.3 Component 3. Aerial Photography, Survey and Production of Orthophoto and Topographic Maps and Satellite Image and establishing a NSDI

According to the Programme Document and design of the programme, the large format digital aerial photography is fully sub-contracted to the same consultant that is carrying out the technical advisory of the programme, i.e. FINNMAP-SKM consortium. FINNMAP mobilized in the latter half of November a Piper Cheyenne II twin-engine aerial survey aircraft together with combination of Vexcel UltraCam-Xp digital large format frame camera and IGI Aerocontrol IId DGPS/IMU system for the photography. Aerial photography operations were

carried out from Pakse airport as aerial operation base from November 28th 2010 until 17th January 2011. Using a large format digital frame camera in the project is essentially important due to its efficiency (no film processing nor film scanning needed), superior image quality compared to analogue film camera and possibility to produce RGB (true colour), CIR (colour infra-red) and B/W photographs from the same raw image data required for environmental (EIA) and NRM applications.

Vexcel's large-format digital aerial camera UltraCam-Xp is a metric frame camera, designed for precision photogrammetric applications. The sensor unit is based on a multi-head design, which combines a set of 9 medium format CCD sensors into a large format panchromatic image. The multispectral channels are supported by 4 additional CCD sensors. Synchronization of the mid-shutter feedback pulse is within the accuracy of 1 millisecond. The panchromatic image of UCXp consists of 17,310 pixels across track and 11,310 pixels along track. Colour is simultaneously recorded for red, green, blue (RGB) and near infrared (NIR). The Vexcel UltraCam-Xp is equipped with Forward Motion Compensation (FMC) system and has full facilities and interfaces for Differential GPS/IMU data collection.

Employment of airborne DGPS/IMU system for obtaining the projection centre coordinates and attitude data is providing important support data for aerial triangulation. Using IMU recording on board it is always important to calibrate the whole camera-IMU system, i.e. determine the boresight misalignment of the two sensors, where 3D coordinate systems of both camera and inertial measurement unit (IMU) are calibrated at the same time and a misalignment of these two coordinate systems is defined accurately.

Prior to the aerial photography campaign was launched, pre-marking of established ground control stations and bench marks was carried out using visible material and background contrast material strong enough to endure the duration of aerial survey campaign. For the 0.45 m GSD aerial photography the dimensions of legs of signals (Y-shape) are 0.8 m x 3.0 m. Pre-signalized stations will serve as ground control points in the combined aerial triangulation and block adjustment computations.

The AEROcontrol IId is a GPS and aircraft directional gyro based guidance, positioning and sensor management system with DGPS/IMU for aerial survey flight missions, compatible with UltraCam-Xp and GSM3000 gyro-stabilized camera mount. The AEROcontrol IId includes an integrated 12-channel L1/L2 GPS receiver and the IMU-IId provides a high accuracy measurement of the angular rate (standard deviation better than 0.006° for roll and pitch, and better than 0.012° for yaw). Dual frequency GPS receivers were used at base stations (five base stations in total) at intervals of approx. 100-150 km on the ground during the photography flights in Lao PDR. Computed WGS84 coordinates of camera positions at the instant of exposures will be used in digital aerial triangulation and block adjustment computations for topographic mapping, DEM generation and orthophoto.

The project area for fresh digital photography, orthophoto production and 1:50,000 topographic mapping is illustrated below in Figure 1.

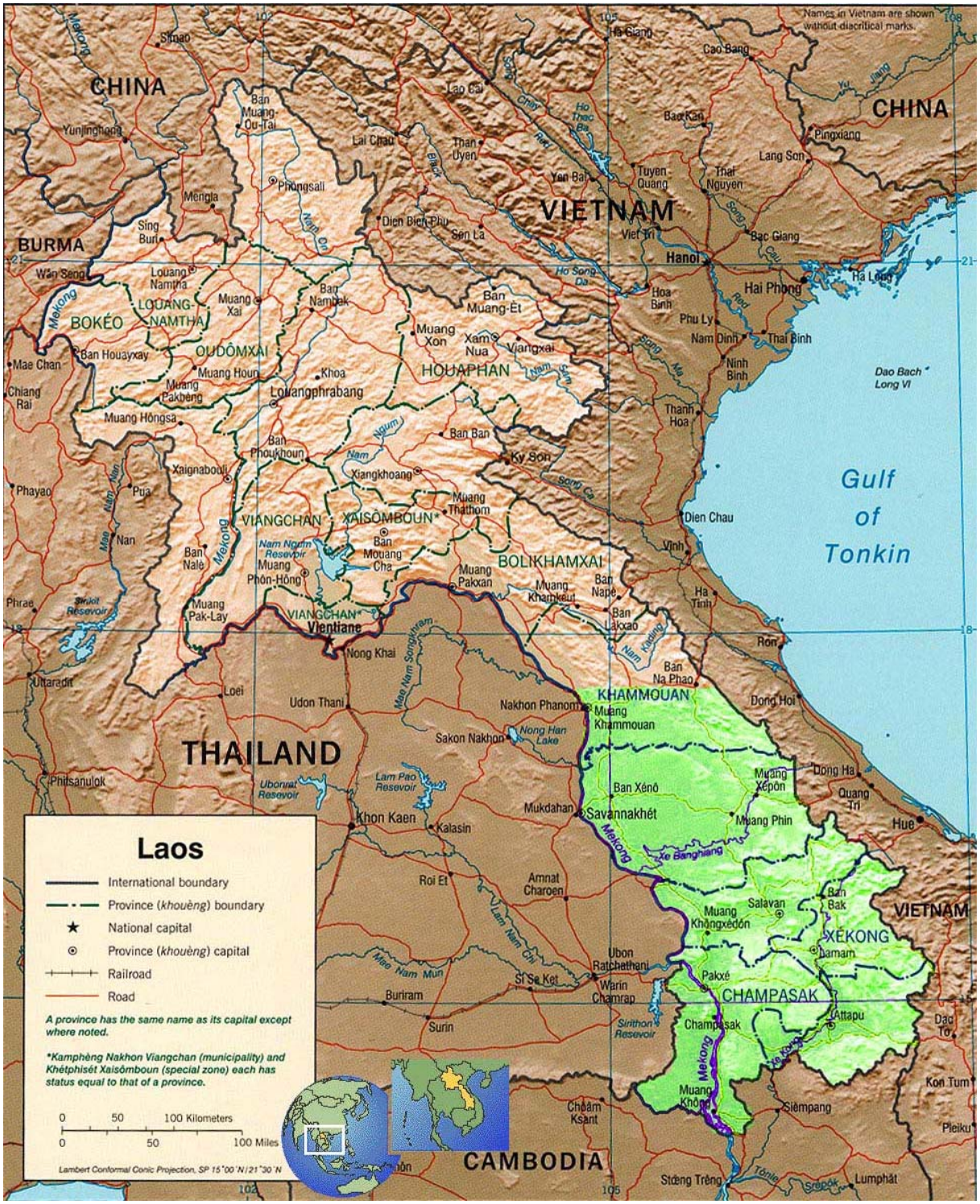

Figure 1. Map of Laos with mapping area of SNGS highlighted with green colour.

2.3.1 Sub-component 3.1: Densification of geodetic ground control network

Official horizontal geodetic datum LAO97 was established in 1997 based on GPS technology where LAO97 datum is using Krassowsky 1940 ellipsoid having its co-ordinate axes parallel with World Geodetic System 1984 (WGS84). Seven LAO97 1st order stations were evenly distributed over the country and were connected to the Asia Pacific Regional Geodetic Project (APGRP) in 1998. Transformation parameters between LAO97 and WGS84 were determined. LAO97 datum is an accurate coordinate system for modern mapping purposes, but the monumented GPS-network is still very sparse and needs densification. GPS-technology is used widely in Laos but many of its users are not aware of the parameters of transferring GPS data to Lao97 datum. The sub-component includes: review of the existing geodetic network, review of the existing datum, densification of the horizontal and vertical geodetic network first in the project area, later on all over the country and review and improvement of transformation parameters between various data sets.

Official vertical datum of Lao PDR is Hondau Datum, based on a mean sea level determined at Hondau, Vietnam. Sparse levelling network covers all of Laos but many of the bench marks, built 25 years ago, are destroyed or missing. This leads to expensive exercises in survey activities since the nearest existing bench mark is often dozens of kilometres away from project sites. Levelling network densification and proper monumentation is needed for the future use.

New 1st order GPS-network will be monumented with an approximate station spacing of 40-60 km and connected to existing accurate WGS84 or ITRF stations in Lao PDR. Similarly, densification of levelling network as well as levelling of part of the monumented GPS stations will be done depending on their locations. Geoid model can be later on computed based on stations' ellipsoidal heights by GPS and orthometric MSL elevations by levelling. Geoid model will be used for computing orthometric MSL elevations for the GPS stations with difficult access for levelling. In parallel to monumentation works public awareness and education campaign to explain the use of the monuments will be undertaken to limit damage and destruction of the monuments.

Figure 2 below illustrates the current geodetic control point network of Laos, the 7 APGRP points indicated separately.

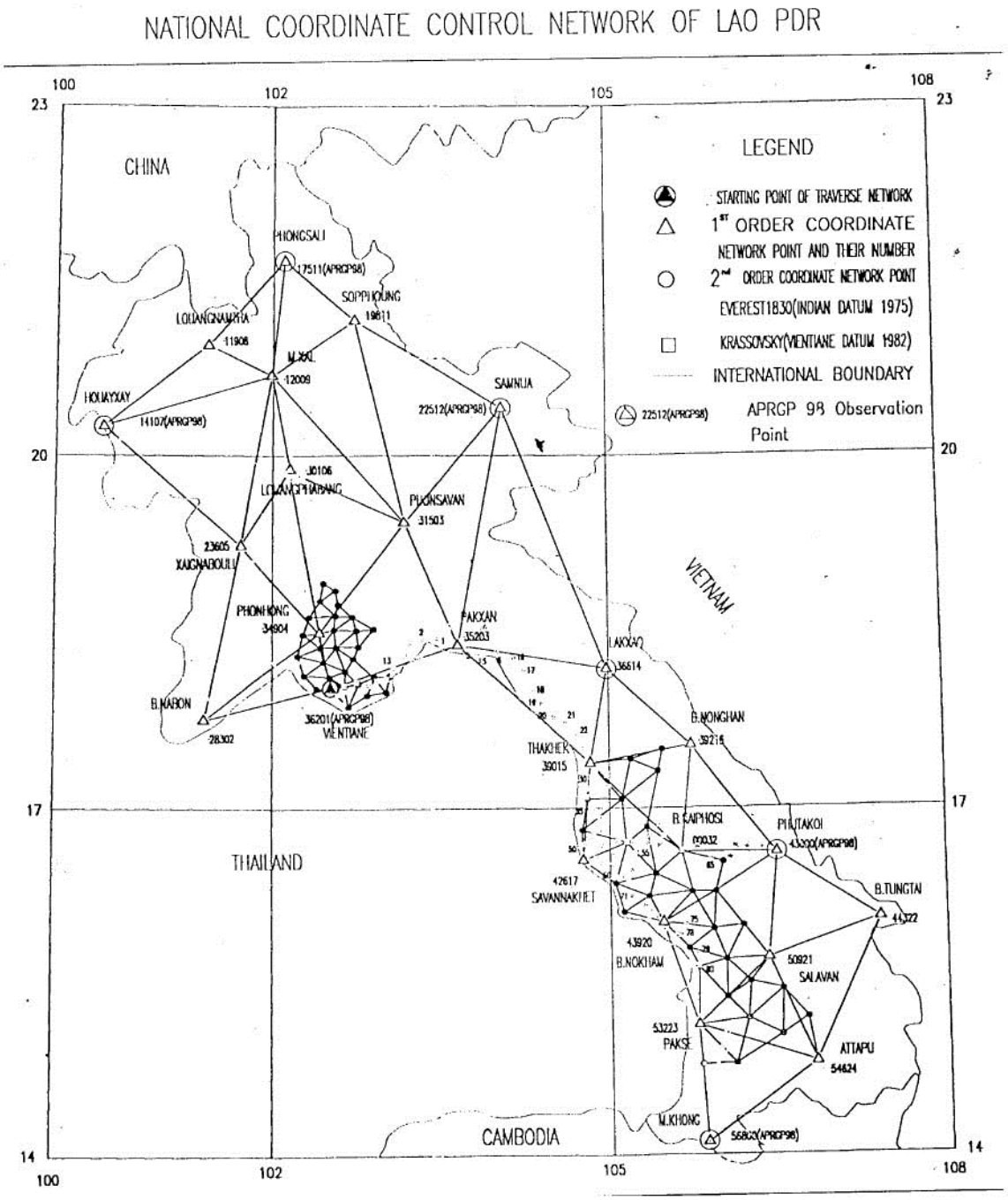

Figure 2. Lao97 new geodetic network with APRGP98 ITRF96 stations

2.3.2 Sub-Component 3.2: Production of digital orthophoto maps and digital/printed 1:50,000 topographical maps

The objective for the Sub-component 3.2 is to utilize the newly obtained 0.5 m GSD digital aerial images covering 71,000 km² of Lao PDR in Savannakhet, Saravan, Champasak,

Xekong, Attapu provinces and in southern part of the Khammouan province. The end products of the sub-component will be 1:5,000 orthophoto maps and 1:50,000 topographic maps over the mentioned part of Lao PDR. All mapping works will be carried out by the permanent personnel of NGD under guidance and supervision by consultant's TA-team. All the software and hardware needed for this exercise will be procured within the programme. The work phases, included in the sub-component can be listed as: digital aerial triangulation, automatic DEM generation, DTM editing, orthorectification, orthomosaicing, contour generation, 2D-digitizing from orthophotos and cartographic mapping. Even having a good variety of tangible geo-spatial end products, the entire Sub-component 3.2 can also be considered as part of the capacity building for NGD.

The clients of NGD expect urgently both, up-to-date and accurate digital orthophoto maps and topographic maps at scale of 1:50,000 from NGD. Data contents in these products are different and orthophoto maps are a new product in Lao PDR. Production and delivery of the orthophoto maps will be organised efficiently so that all of the orthophoto maps are in active use in two years from the start of the programme. Production of the topographic maps is slower, but during the four year programme the completed digital sheets will be ready for distributing to the clients and stakeholders.

2.3.3 Sub-Component 3.3: Updating and preparation of selected urban and suburban digital topographic maps at scale 1:5 000

This sub-component includes several activities, which will be planned in more details during the programme. The digital aerial photography described above and production of the orthophoto maps allows updating of the existing outdated digital 1:5,000 topographic maps in the three major towns of the project area (Pakse, Savannakhet, Thakhek). The Cartography Division of NGD has been carrying out an updating project of 1:5,000 maps of Pakse during the inception period of SNGS. The fresh digital aerial photographs (just a couple of weeks old) were also used for updating.

Vientiane plain area, which also has previous but outdated 1:5,000 digital topographic maps, is covered by Quickbird satellite images from January 2008. In case of need, the updating of Vientiane plain maps can be implemented based on this satellite material.

The programme also includes provision of small format digital camera for NGD and assistance to NGD in using it in limited updating or mapping tasks preferably in urban and suburban areas. These urban tasks are not very urgent and the work with them may concentrate mainly for the second half of the programme.

2.3.4 Sub-Component 3.4: Satellite orthoimage mosaic over Laos

Because this four years programme phase cannot afford a full aerial photography and topographic mapping of the country and several clients of NGD (forestry, environmental protection, large scale land use planning etc.) need satellite material all over the country the

production of orthorectified satellite image mosaic is included in the programme. The state authorities of Lao PDR already have rather well up to date and complete coverage of different satellite imagery over the country. The first step of this sub-component is to get all this different satellite imagery into NGD's possession according the data sharing policies. It is obvious that NGD needs to rectify the imagery again and mosaic that material with the SNGS programme support after receiving the satellite data from different organisations.

2.3.5 Sub-Component 3.5: IT/GIS/Computer Network and Database Management established for NSDI

During the activities of the programme the IT/GIS network inside NGD has to operate properly, the data produced needs proper saving and backups, and the delivery of digital geographic data to the clients has to be arranged efficiently. In parallel with the mapping line work a geospatial database will be designed and created to accommodate all extracted features. The database will be based on system and software solutions used before in NGD and those procured within the programme. In the selection of the geospatial database architecture/design, short review of existing similar systems and software in Lao PDR will be conducted. This ensures that selected format is compatible and easily provided to other entities needing geospatial information.

3. COMPATIBILITY AND STRATEGIC GOALS

3.1 Compatibility with the Finnish and Lao development policies

The document "Development Policy Programme 2007, Towards a Sustainable and Just World Community" approved by the Finnish Government presents the policy of the Finnish Government. The programme being implemented is well in line with the strategic goals of Finland's development co-operation. Its objectives, purpose and expected results are in full balance with the Finnish development objectives. It has also good synergy with other on-going and planned Finnish co-operation programmes in Lao PDR.

The programme is well in line with the general policies of Lao Government. Availability of up-to date topographic maps, orthophotos and spatial data are important in the management of the development and environment sustainably - their operationalization still need further attention in the policy operationalization level. The project area covers a big part of the natural resources of Lao PDR (forestry, mining and agriculture) and has many land use related conflicting interests. It has rather much population including poor population both in urban, rural and mountainous areas.

3.2 Economic and financial feasibility

The programme includes necessary investments on facilities. Fully digital production line to meet the requirements of digital image processing, digital orthophoto production and digital

base mapping for the basis of NSDI build-up is required to meet the modern requirements. The facilities will be later used for other mapping activities and updating of maps.

Other form of support is technical assistance to install the equipment and train the staff of NGD to operate them. The number of advisory staff will be kept at minimum and the technical advisory is rather based on long term involvement and assistance.

This type of approach is expected to be the most feasible way to collect geographic information ensuring the same time updating of the data as a basis for NSDI as well as future development of NGD. The accuracy of the national investment plans in Lao PDR does not allow a meaningful economic or financial analysis of the project. Experience from other countries tells, that proper use of up-to date topographic maps and geographic data may assist in saving 3-6 % in the national infrastructure investments. In Lao conditions the benefits of proper management of natural resources in long term are extremely important for the national economy. Investment in proper geographic data and in this project will without any doubt bring much higher benefits.

3.3 Institutional capacity

The NGD organisation is divided to three main lines of which two are under deputy directors and seven divisions. The most important partners for the programme are the four divisions under the two deputy directors. The important divisions are: photogrammetric division, cartographic division, surveying division and financial division.

The total staff of NGD is 120 person of which 101 are professionals. Of the total staff 87 are men and 33 are women. Many of the employees have long work experience in NGD and they have the basic capacity for typical key tasks in NGD. The challenges of new modern technology and improved efficiency, however, need serious inputs from the programme in on the job training.

The present human resources are sufficient enough to achieve the production targets, when 40-50 % of the personnel can be assigned to the programme for the next four years. NGD is planning to employ annually some 5 additional personnel from the technical school of Vientiane where 100 new survey technicians complete their education every year. They, however, need specialised practical on the job training before being fully productive in NGD. The staff involved in the activities and on the job training of the programme will rotate to give for as many as possible a possibility to learn the new skills. After the programme the department will have capacity to start other priority mapping projects at different scales, update existing maps and produce special products utilising existing data.

NGD has moved in September 2009 into a brand new office building. This provides a good space for the programme implementation and capacity building, and allows NGD many new possibilities for its development.

The capacity of NGD has permanently suffered on two problems. NGD has not been able to

do any aerial photography of its own nor to procure photography services from any sources without external donor funding. This programme provides NGD with basic equipment for at least limited own photography, but renting of aeroplane seems still to be a challenge for NGD.

3.4 Socio-cultural aspects

The maps and data produced in the project has mainly local but also international users. The map titles, legends and place names have recently been presented in both Lao and Latin letters / English texts. This practice will be used also in this programme.

Including administrative boundaries of provinces and districts, even if they may not be fully clear, in the maps will help the various authorities in the management of the area. The national boundary in the project area may also not be fully clear, but needs naturally to be presented. Identification of the villages may be partly a sensitive issue. At least the villages identified in the Census 2005 need to be identified in the maps, but presentation of their boundaries is impossible. According to some information there are however more villages in the reality, than in the Census. Especially in the mountainous border areas several villages may not have been identified or they were wrongly located in the Census. As far as they do not officially exist, their financial support, services, land rights and legal position are not clear. Their population may consist of the poorest population groups often from ethnic minorities. The exploiting of natural resources is a threat to such groups. The programme offers an interesting opportunity to identify both official and unofficial villages in the project area and in this way indirectly to promote the human rights of some of the weakest population groups in the Lao society.

3.5 Participation and ownership

The basic concept of the programme is based on the idea of support the development of NGD. This implies that NGD is expected to show ownership to the project as well as participation in its implementation. It is the responsibility of the advisors to develop the participation. Ownership does not mean only ownership of NGD's management, but of all employees and stakeholders, in order to feel interest and responsibility in the operation and development of survey, mapping and aerial photography. Good results cannot be expected without participation of all stakeholders. Participation means active and free communication on own initiative, provision of services in mutual understanding in agreement with job descriptions and good workmanship.

The culture of reading and utilising maps is a cultural skill to be learned and, therefore, should not be taken for granted. The government officers who work outside the NGD may need support to be able to make use of the maps. The participation to the programme requires training and information dissemination campaigns also outside the NGD.

3.6 Gender

The programme is rather neutral in regard of gender issues. The maps and other map-related

data will be provided to all customers regardless of the gender. The training of NGD staff will be given equally to both genders. Both men and women in the NGD staff will be equally active in the programme. Today slightly more women act in the cartographic and photogrammetric works in NGD office than men. In the field surveys more men are acting. The management of NGD is male dominated. The products of the programme for NSDI build-up can be used in gender specific projects.

3.7 Environment

Mapping, surveying and production of geographic data will have no negative environmental impacts. Instead the topographic maps, orthophoto maps and satellite imagery are absolutely necessary tools in the sustainable management of the natural resources and environment. The orthophotos and satellite images show in details the status of agriculture, forestry and in fact key features of the visible environment more quickly and reliably than any other methods. Illegal logging for example is easy to locate with this material. The accurate topographic and orthophoto maps allow clarification and registration of locations of hundreds of existing and future concessions partly threatening the environment, often creating both land use conflicts and social conflicts especially in the rural areas and at the village level. The conservation areas need to be located and registered properly. Environmental planning and land use planning cannot be efficient without up to date topographic maps, orthophoto maps and satellite data. Proper geographic information, common for all authorities, allows coordination and integration between the different sector authorities and their interests.

3.8 Appropriate technology

One of the important technical aims of the programme is to develop the present map production line into fully digital production line utilising digital aerial images. Fully digital production line includes automatic aerial triangulation software, automatic digital elevation model generation software and ortho-rectification and mosaicking software to be utilised. Competent trained experts are needed to operate and analyse the automated processes. Digital elevation model editing, seam line editing, 2D-digitizing and map editing of topographic data require the most of relevant human resources of the NGD.

New skills to be acquired highly relate with computer skills. They are relatively easy to learn as the professional knowledge of different disciplines of mapping and surveying already exist within NGD. The personnel are already familiar with ArcGIS and AutoCAD. The new software and technology shall as far as possible be based on the existing and known technology in NGD.

The technology in mapping and in GIS systems is developing fast and getting old within few years. That is a serious challenge for NGD. The existing office of NGD has a lot of old equipment no more in use like analogue (optic, film based) stereo plotters, huge repro camera, a full map printing press not in use etc. The map printing press is technically capable, but lacks the financing for operational costs for materials like for plates, films, colours etc. In the new project the use of this printing press or outsourcing these services are both possible. The

archives and sales facilities are in a need of modernisation.

4. CONCLUSIONS

The programme *Strengthening National Geographic Services in Lao PDR* is without a doubt a well justified and well-designed technical co-operation programme; but on the other hand, an extremely challenging programme also. As the programme is still in very early stage, inception period just ended, this paper only gives a brief introduction to the programme and not yet any tangible results. We are looking forward to report the progress and results within the coming FIG congresses and working weeks.

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