RIGHT OF WAY MANAGEMENT SYSTEM IN CAMBODIA

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Abstract

Ministry of Public Works and Transport of Cambodia (MPWT) supported by Japan International Cooperation Agency (JICA) has developed a Right-of-Way (ROW) management system by using Unmanned Aerial Vehicle (UAV) mapping and the Geographic Information System (GIS) database to identify current situation of obstacles within ROW and to prevent new illegal encroachment along the national roads.

1. Introduction

Illegal encroachment is one of the major tackling issues of road improvement projects in Cambodia, especially projects for widening of existing national roads. As a road management authority, MPWT had been tried to keep ROW lines for the future widening project, however, illegal encroachment within ROW are still commonly observed due to lack of ROW management system. Considering that situation, MPWT launched the specific project, which is called CESCoR (Capacity Enhancement of Environment and Social Considerations in Implementing Agency in Road Sector), to establish integrated ROW Management System (RMS) with assistance from JICA.

This paper mainly introduces Current Status Identification (CSI), which has been developed with technology of UAV mapping and the GIS database. CSI plays important roles for RMS to record illegal structures, illegal land use, and other obstacles within ROW at a certain date (cut-off-date). Aerial photos taken by UAVs are assembled and translated into continuous orthophotograph with coordination as the first step of analyzation in the back-office. Following land surveys can add further properties on target object, such as houses, kiosks, land use and etc., for the final map (ROW Management Map, RMM) and database (ROW Management Database, RMD).

After establishment of RMS which mainly consists of RMM and RMD, monitoring teams of ROW management, such as local authorities, can use RMS for their periodical maintenance of road and update any changings within ROW including new encroachment by using tablets connecting to RMD. Thus, CSI supported by RMS is followed by the next step of Illegal Encroachment Prevention (IEP) including education, fencing, and so on, to reduce the number of encroachments. These activities may contribute to reduce both impact on illegal Project Affected Persons (PAPs) and cost on compensation for resettlement when road widening projects come to the area in the future.

2. Outline of Pilot Project for RMS Development

2.1 Target Area

Fig.1 shows the target area of Pilot Project, about 366km of national road No.5 (from Capital City of Phnom Penh to the border between Thailand) belongs to four Provinces (Kampong Chhnang, Pursat, Battambang and Banteay Meanchey). There are urban, rural, residential, commercial, agricultural area along the road. Some structures are constructed inside ROW or extend roofs after construction, reaching inside ROW. Also, some of those living

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along the road landfill soil and bricks over open drainage canals to connect their houses and the road, causing the road to get flooded. However, it is considered that the road indicates higher development potential than other roads due to part of Asian Highway Network and the Southern Economic Corridor, requiring ROW management prior to them.

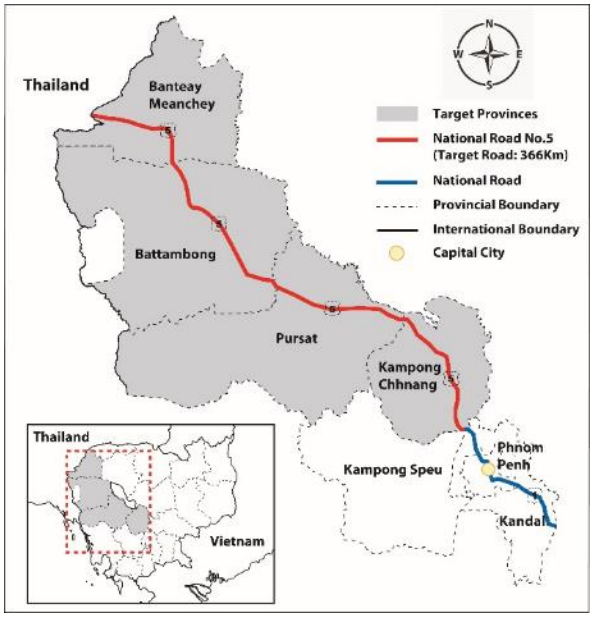

Fig.1 Target Area of Pilot Project

Pic.1 Built-up Area along National Road No.5

Pic.2 Rural Area along National Road No.5

2.2 ROW in Cambodia

"ROW" is multi-meaning word in different situation, such as traffic rules, land access, and so on. In Cambodia, ROW means state land along the road with fixed distances from the centerline of existing roads for the future development. Legal Bases, Ministerial Orders (Prakas in Khmer) in 1999 and Sub-Decree (Anu-Kret in Khmer) in 2009, define the distances based on road level as summarized in the **Table 1**.

Table 1 Definitions of Right of Way based on Legal Bases

Road level	ROW Dimensions	
	Ministerial Orders No. 06, 1999	Sub-Decree No. 197, 2009
National roads (NR1, 4 and 5)	30 m length from the centerline	30 m length from the centerline
National roads (others of 1-digit number)	25 m length from the centerline	
National roads (2-digits number)	25 m length from the centerline	25 m length from the centerline
Provincial roads	20 m length from the centerline	Not specified
Commune Roads	15m	Not specified

2.3 Institutional Arrangement

Roads Infrastructure Department (RID) in MPWT manage the road and ROW by creating the relevant legal regulations under duties and responsibilities stated in Sub-Degree No 14, 1998. On the other hand, Department of Public Works and Transport (DPWT) of each province, which is a sub-national specialized unit under MPWT, follows all policies and legal documents prepared by MPWT, especially RID in case of ROW, within the domain of the department.

Government of Japan has focused on socio-economic infrastructure development in Cambodia as a prioritized sector for Official Development Assistance (ODA) in early 1990s. Then, JICA pays much attention to which the recipient country appropriately manage ROW, acquire land and offer resettlement programs for smooth

and beneficial infrastructure projects. Thus, the proper management of ROW plays necessary rolls for not only MPWT, the road development/management authority but also JICA.

3. Methodology

3.1 UAV aerial imagery

There are propeller-typed (propeller) or fixed-wing-typed (fixed-wing) UAV which are characterized each from the perspective of operability, economy and efficiency. It is considered that the former has easier handling and more moderate product price, but its flight length per one flight is restricted. In contrast, the latter can fly over a longer distance, although operation process is a little complicated, requiring more time to acquire enough to operate safely, and the product cost is more expensive. In the target area shown in clause **2.1**, propeller is mainly applied to take aerial images.

Table 2 Specification of UAV

Item	propeller-typed UAV	fixed-wing-typed UAV
Product	Approx. $2,000	Approx. $18,000
Weight	1800g	800g
Height	50 – 150m (Auto-image capturing)	75 – 1,000m
Endurance	15min (Auto-image capturing)	50min
Flight Speed	20km/h (Auto-image capturing)	80km/h
Camera	20MP, 4.38cm GSD (100m height)	16.1MP, 3.5cm GSD (100m height)
Takeoff and Landing	Space with 3m*3m	Space with 10m*10m
Flight Length	Approx. 500 - 1,000m	Approx. 7~10km

Flight planning has three steps basically. First, flight blocks (polygon data) with 500 meters length and 100 meters width is created and arranged at equal intervals on QGIS in office. With this creation, UAV operators can draw flight path accurately and with less human error on UAV flight application at the site. Second, Flight height is set at 100 meters in which aerial imagery covers ROW completely and Ground Sample Distance (GSD) maintains a certain level capable of identifying visually road centerlines and structure, drawing them obviously. Since Cambodia's topography has small elevation differences, it is considered that flight height may remain 100 meters even on most state and local roads that exist outside the target area. Third, Ground Control Points (GCPs) are marked on the ground and recorded for their geographic location with a handy GPS device before taking aerial photos.

3.2 Image Processing and Data Production

Ortho-images (Ortho), which are raster datum and used as a framework data, are created by merging aerial images with Pix4D mapper, the photogrammetry software for drone mapping. The output must be Cambodia's coordination system, World Geodetic System 1984 / UTM Zone 48N (egm96). With this creation, vector datum can be drawn and produced on Ortho to express existing features such as road centerlines as well as non-exiting features such as ROW boundaries as shown the **Fig.2**. ROW boundaries should exist along the lines with fixed distances from the centerline of existing roads, so the drawn centerline on QGIS is used as input features to create buffer polygons, the ROW boundaries. Then, buildings and other necessary features within ROW are drawn and saved as shp files with attribute information as a point, line or polygon data.

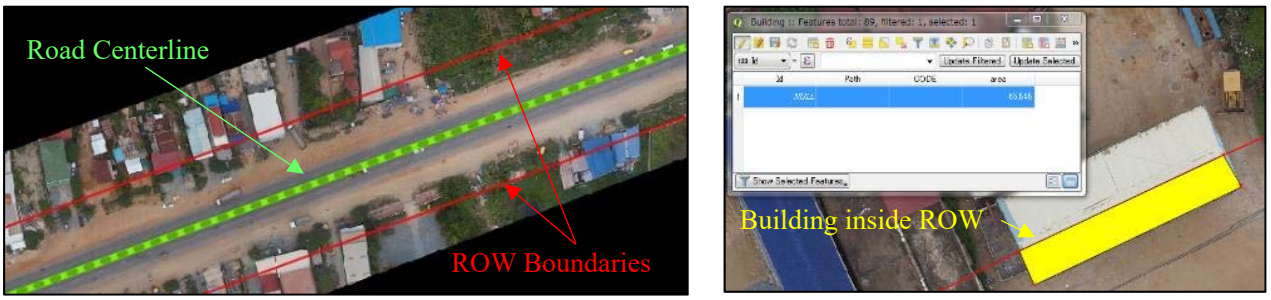

Fig.2 Data Production on Ortho of Road centerlines, ROW Boundaries and buildings inside ROW

3.3 Database, Field Survey and Data Finalization

Server and the Web GIS system are constructed to realize referencing and inputting information in field with the following procedures. First, shp files created by QGIS are converted to database format for PostgreSQL/PostGIS. Second, ground photos taken at field survey following data production are developed as database, making a link with each shp file. Third, base map for the bottom layer at browser application is set up by the database such Ortho and exiting survey maps. Then field surveyors can store shp files and base map for the modification from database server to the tablet for the survey. In this connection, it should be noted that limited function database for field surveyors is split from full function database as administrative function.

Field surveyors can modify/update property information such as to input text by typing and selecting, take images by tablet camera and make link with the point and then update modified shp files from tablet to database server through internet connection after the survey. The history of modified shp files in the database server is recorded, so it is possible that the administrator checks it finally. What database items should be stored for efficient and effective ROW management, are currently under consideration. These items should be considered and determined for how IEP should be implemented. One example of it is building/built-up Area, mobile shop, land filling over open drainage canals, open/bush area and wet land/rice field.

3.4 IEP

CSI provides not only baseline data of ROW management, but also shows results of thematic analysis, such as potential of future illegal encroachment along a road with indicators of population density. Because urbanized area shall be managed by actual border between road and structures based on land registration, the targets of IEP, the second step of ROW Management, are peri-urban and rural areas where new encroachment may occur in the future. According to the conditions of road side environment, suitable and effective soft and hard measures for IEP are recommended by RMS. Typical measures are shown in **Fig.3**.

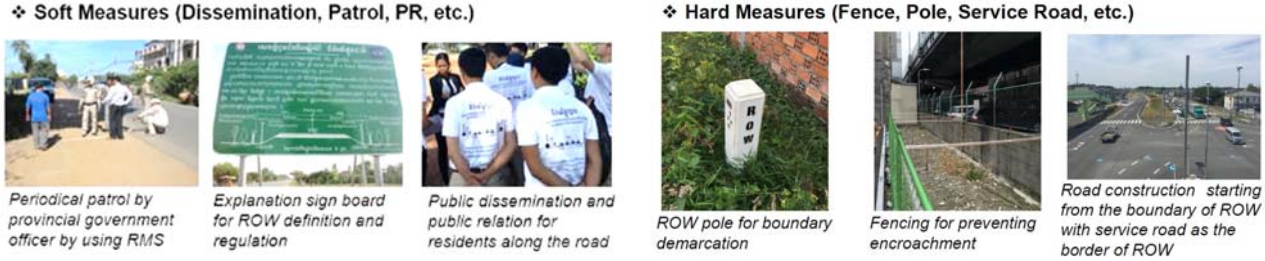

Fig.3 Typical Measures for IEP

4. Conclusion

This paper presented concrete methodology to identify current status for ROW management: (1) UAV Aerial Imagery (2) Image Processing (3) Data Production (4) Database (5) Field Survey (6) Data Finalization. These processes are based on technique of UAV mapping and GIS database, which is different from the conventional method with cadastral datum and land registration, which requires accurate surveying and takes more time to be registered legally. It is considered that as illegal encroachment cause bottleneck of road improvement projects in Cambodia, the situation in which the problem is solved in rapid manner would increase. This pioneering initiative is expected to produce a derivative effect and lead to further horizontal development for other countries with the same difficulty.