Site Assessment for Large Scale Organic Agriculture Plot using Integrated Geoinformatic and Sub-Global Assessment Case Study of Nong Wang Sok Phra, Phon District, Khon Kaen, Thailand

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Abstract

Organic agriculture has been currently promoted by the governmental policy to meet sustainable agriculture development. To enhance organic agriculture, Nong Wang Sok Phra, Phon District, Khon Kaen, Thailand has designated organic agriculture plot covering the area of 2,000 rai (320 hectare) along the creek. It is necessary to identify boundary of organic agriculture plot with land use and perception of organic agriculture plot member. The objective of this research, thus, was to assess the large scale of organic agriculture plot by integrating Geoinformatic together with Unmanned Arial Vehicle and Sub-global Assessment (SGA). The study steps and results are as follows. Firstly, creating the study area and land use map with physical characteristics identified by photography and video record. Secondly, establishing the systematic maps of large scale of organic agriculture. by criteria weighting and rating scale for analysis of land suitability, using Geoinformatic and UAV Arial Photography of 7 factors consisting of land use, soil suitability, water resource, transportation, average debt of village, acceptation of member, organic agriculture plot definition. Social study using SGA approach was carried out after getting systematic by focus group interview on debt of farmers and acceptation of organic agriculture plot's members. Thirdly, Arial Photography taken from Unmanned Aerial Vehicle (UAV) for the potential large organic agriculture plot covering many land parcels. Again, SGA identified the suitable plot ranked from the potential large organic agriculture plot. Finally, with the overlay technic with processing UAV Imagery and parcel maps, the output was the map of suitable organic agriculture plot, located at Ban Kok Lam Village no.3, covering plot of 129 rai (20.64 hectare), where the agriculture parcels were belonged to 25 owners. With technical and social acceptance would identify the actual organic agriculture area.

Keywords : Organic Agriculture plot; UAV Arial Photography; Sub-Global Assessment

Introduction

The promotion of large scale agriculture plot is the agriculture preferment system on plot based approach by integration of the line agencies and managing the plot along the supply chain by the plot manager. The purpose of the large scale agriculture plot is to enhance collaboration of farmers and co-managing in order to co-production, co-sale with the known market. With the large scale agriculture promotion project, the farmers can reduce production cost, increase product/unit as well as qualified products under integration of governmental and private sectors [1]. However, the conventional agriculture both small and large scales have still used chemical fertilizer and pesticides which are potentially impacted on soil and water ecosystem as well as health of farmers. Data of illness induced by chemical pesticides reported in 2017 was 10,312 patients being equivalent to 17.12 to 100,000 people, which increased from 8,689 patients (14.47 to 100,000 people) recorded in 2016. The highest illness rate was found in Satoon province (144.06 to 100,000 people) followed by Prae Province (127.26 to 100,000 people) and Uttaradit Province (116.98 to 100,000 people), respectively. Based on the number of patients, three provinces had the highest number of patients were Phrae Province (572 patients), Uttaradit Province (536 patients) and Buriram Province (533 patients), respectively. Khon Kaen Province (the study area) had 478 patients being equivalent to 26.53 to 100,000 people [2].

Therefore, organic agriculture is the solution of agriculture practice that is safe to human health and ecosystem. The government has policy on organic agriculture enhancement by setting the target of increasing organic agriculture plot and farmers, increasing the ratio of organic agriculture market within the country as well as leveraging the local wisdom organic agriculture group toward the development of organic agriculture of Thailand, as the regional leader of production, consumption, marketing and service of organic agriculture on the sustainable concept and international acceptance following the National Organic Agriculture Development Strategy 2017-2021 [3].

In addition, it is still questionable to identify the large scale of agriculture organic plot in terms of land use map with boundary and acceptance of farmers. In order to enhance organic agriculture which is safe to human health and environment, it requires an integration of spatial data and Sub-Global Assessment (SGA which is the social study to get the scientific information toward decision making) which reflect the spatial planning map with acceptance of farmers. Consequently, this study focused integration of Geoinformatic, Sub-Global Assessment [4] in order to select the large scale of organic agriculture plot.

Objective

The objective is to assess the site for large scale organic agriculture plot using Integrated Geoinformatic and Sub-Global Assessment.

Materials and Methods

Study area is organic agriculture pilot area designated in 4 year Development Plan (2017-2021) of Nong Wang Sok Phra Sub-District Administration Organization, Phon District, Khon Kaen Province (Figure 1) [5]. Study methodology consisted of following steps as subsequently described (Figure 2).
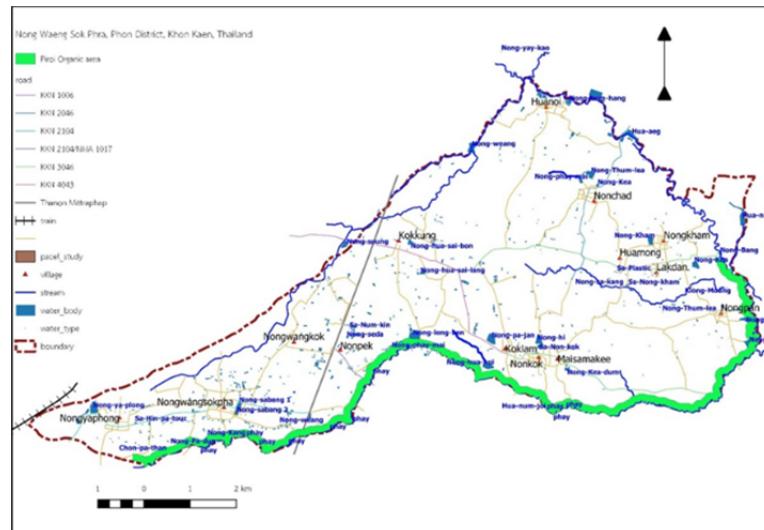
Figure 1 Study Area on Organic Agriculture Pilot Area Designated in 4 year Development Plan (2017-2021) of Nong Wang Sok Phra Sub-District Administration Organization, Phon District, Khon Kaen Province
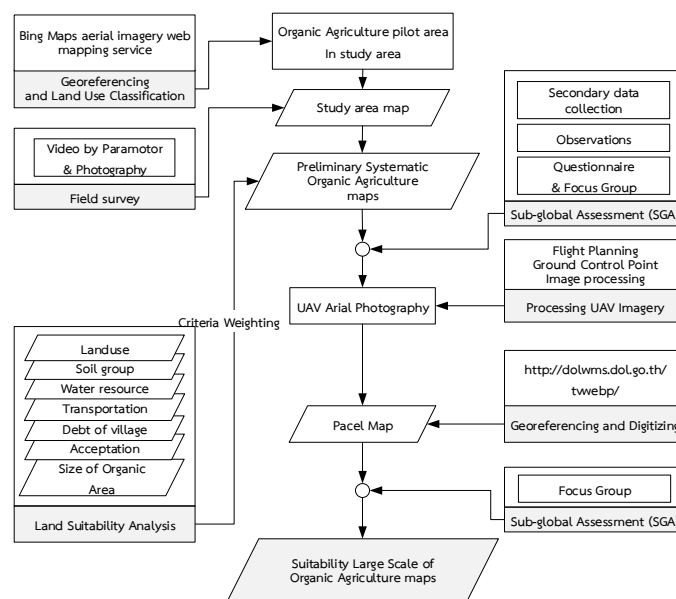

Figure 2 Study Steps

1. First step was to create study area and land use map by following sub-steps.

　　1) Creating the study area and land use map by geo-referencing of Bing Maps Aerial Imagery Web Mapping service and classify land use on the organic agriculture pilot area.

Checking the study area through field survey with video record and photography by camera equipped paramotor to illustrate physical characteristics of the study area.

2. Second step was to establish the preliminary systematic maps of large scale

of organic agriculture plot which included following sub-steps.

1) Establishing the preliminary systematic maps of large scale of organic agriculture by criteria weighting and rating scale to analyze for land suitability. The criteria consisted of land use, soil suitability, water resource, transportation, average debt of village, acceptation of member, organic agriculture plot defined by the Ministry of Agriculture and Cooperation [4].

2) Collecting secondary data and field survey by observations and photography to define the physical characteristics of the study area. In the meantime, SGA had been employed to collect agricultural data and information through focus group and questionnaire in order to perceive and understand the large scale organic agriculture plot.

3. Third step was to check the preliminary systematic maps of large scale of organic agriculture by

3.1 Recording image with UAV and processing UAV Imagery by

1) Site selected for fight recording

2) Ground control point [6] by creating ground control targets [7].

3) Recording geographic coordinate systems at ground control point with GNSS.

4) Flight planning through flight control program of UAV DJI GO.

5) UAV image processing by Agisoft PhotoScan 1.4.5 Professional Edition software with geometric correction and image to map rectification.

3.2 Establishing suitable large scale of organic agriculture maps by

1) Creating parcel maps of the study area and digitized imagery parcel owner on web mapping service form Department of Lands Headquarters, Ministry of Interior.

2) Overlay technic with processing UAV Imagery and parcel maps to get the suitable large scale of organic agriculture maps) of the study area.

Results and Discussion

Regarding the land use map created from study steps 1 and 2, land use of organic agriculture plot is defined in Figure 3. It is classified as shown in Table 1, of which paddy field was the most occupied area and forest plantation was the lowest occupied area. With the largest paddy field area, it is beneficial to large scale organic rice field.

Based on the field survey with video and photography with camera equipped at Paramotor (Figure 4), physical characteristics of the study area existed in May 2017, the creek namely Huai Luek fulfilled with water along the stream for 22 km distance. It covered cultivation area of 7 villages with an area of 2,000 rai (320 hectare). Through social approach (preliminary SGA) by questionnaire interview to collect data of the land owner and agriculture data/information, the existing large scale of organic agriculture area had 210 members, cultivation area of 1,310 rai (210 hectare), rice product of 459,000 kg with an average of 350 kg/rai or 2,186 kg/ha, classified as sticky rice as RD 6 / RD 12 and jasmine rice 105. Soil conditioning was mostly used manure of cow and composting fertilizer averagely 100 kg/rai or 625 kg./ha, as presented in Table 1.
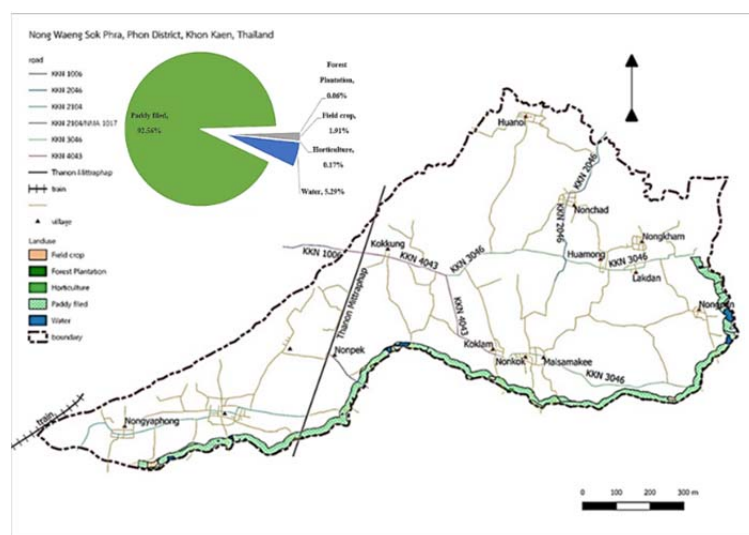
**Figure 3** Land use of Organic Agriculture Pilot Area

In order to analyze for land suitability, it is to create systematic maps of large scale of organic agriculture by criteria weighting and rating scale. Factors, index, and criteria for large scale organic agriculture plot are presented in Table 2. With overlay technic, it produced the preliminary of systematic maps of large scale and organic Agriculture as presented in Figure 5 indicating land suitability of organic agriculture area.

Then, using SGA approach (SGA 1) with such preliminary of systematic maps to find out the perception of members through focus group. Based on discussion with the members, they had still used both compost/manual fertilizer and chemical fertilizer. Of 2,000 rai (320 hectare) could be finally classified for organic agriculture 129 rai (20.64 hectare), which was only 15.50% of total organic pilot area, as shown in Figure 6. In order to present the existing status of the suitable area for large scale organic agriculture, two more steps were performed by using UAV for the background and parcel map of land owner (data taken from Land Use Department) as the foreground as exhibited in Figure 7. Then, this suitable organic agriculture with parcel map was shown to the organic agriculture members for deep perception and understanding (SGA2). Analysis results of the suitable area for large scale organic agriculture plot were evident to all members. It enables acceptance of the members towards organic agriculture development including practice in terms of meeting the criteria leading to increasing organic agriculture members. This integration of technical mean (GIS and UAV) and social mean (SGA) can be used for expansion of organic agriculture plot to meet the target of 2,000 rai (320 hectare) as designated plan.

Table 1 Organic Agriculture Rice Types (from questionnaire)

Rice seed	Member (person)	Area (rai)	Area (Ha)	Product (Kg)	Average Product (Kg./rai)	Average Product (Kg/ ha)
RD 6	163	957	153.12	335,450	350.52	2,190.75
RD12	1	5	0.8	1,750	350	2,187.50
Jusmine105	46	348	55.68	121,800	350	2,187.50
Total	210	1,310	209.6	459,000	350.38	2,189.88
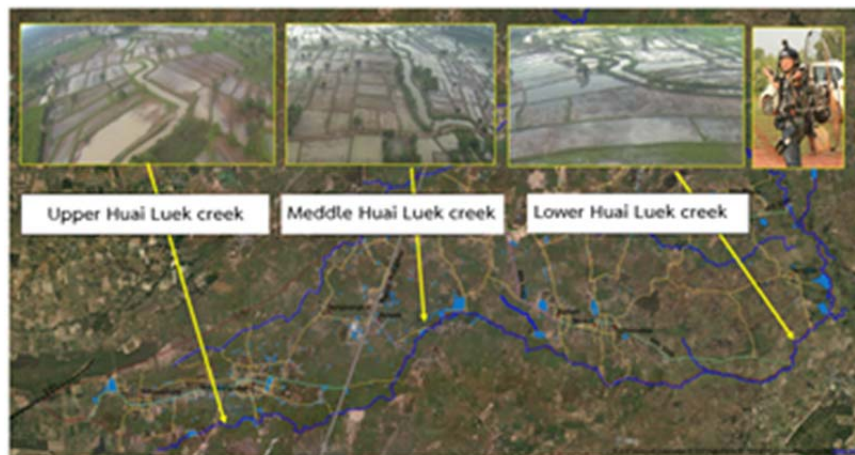
Figure 4 photography with camera equipped at Paramotor

Table 2 Factor, Index, and Criteria for Large Organic Agriculture Area

Factor	Index	Criteria	Data used
Landuse	Suitable level taken from land use	Suitable score taken from land use	Landuse map
Soil	Suitable level of soil	Suitable score taken from soil series	Soil series map
Water resource	Catchment area	Score of catchment area	Water resource map
Transportation	Distance access to main road and minor road, railway line	Score of distance (near or far) access to road	Road map
Organic area	Size of organic area of Ministry of Agriculture.	Score based on size of organic area	Organic Area map
Average debt of village	Average debt/year	Score of average debt/year	Debt map
Acceptation of member	Acceptation for adjustment of organic agriculture to large scale	Score along with acceptation	Accept map

Table 3 Rating and Scaling

| Factor	Review			Researcher	Member	Rating Scale
	(1)	(2)	(3)	(4)	(Organic) (5)	(6)
1.Landuse (P1)	0.09	-	0.130896	0.16	0.15	0.11
2.Soil (P2)	0.01	0.25	0.326998	0.20	0.11	0.18
3.Water resource (P3)	0.25	-	0.296936	0.27	0.27	0.22
4.Transpotation (P4)	-	-	0.035088	0.08	0.08	0.04
5.Organic Area (P5)	-	0.1	-	0.27	0.27	0.15
6.Debt of village (P6)	-	-	-	0.50	0.05	0.20
7.Acceptation (P7)	-	0.15	-	0.20	0.15	0.10

(1) Liu W, 2019 [8].
(2) Vogdrup-Schmidt M et al., 2019 [9].
(3) Sarath Midatana, Saran S, Ramana KV, 2018 [10].
(4) Researcher form average of (1), (2), (3), (5), survey and observation
(5) Questionnaire
(6) Average of (1) – (5)
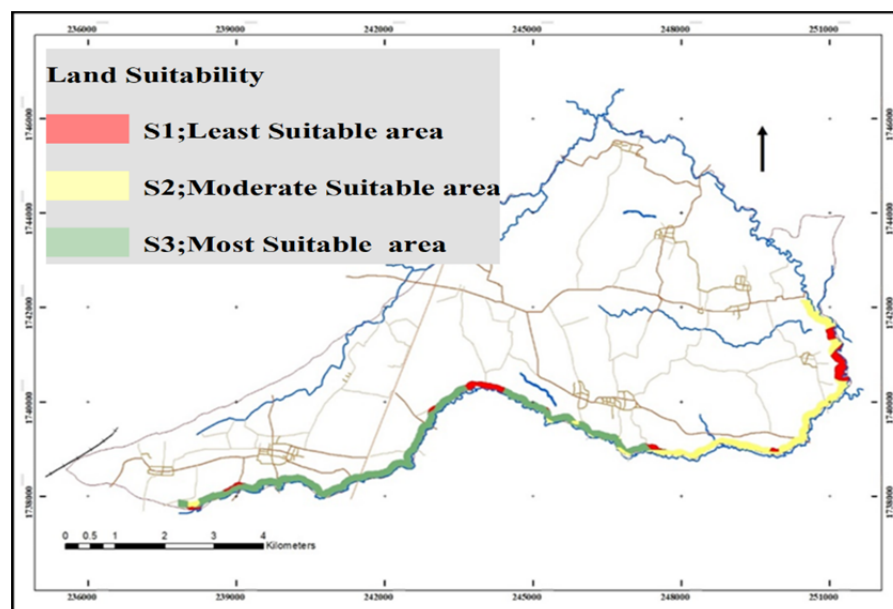
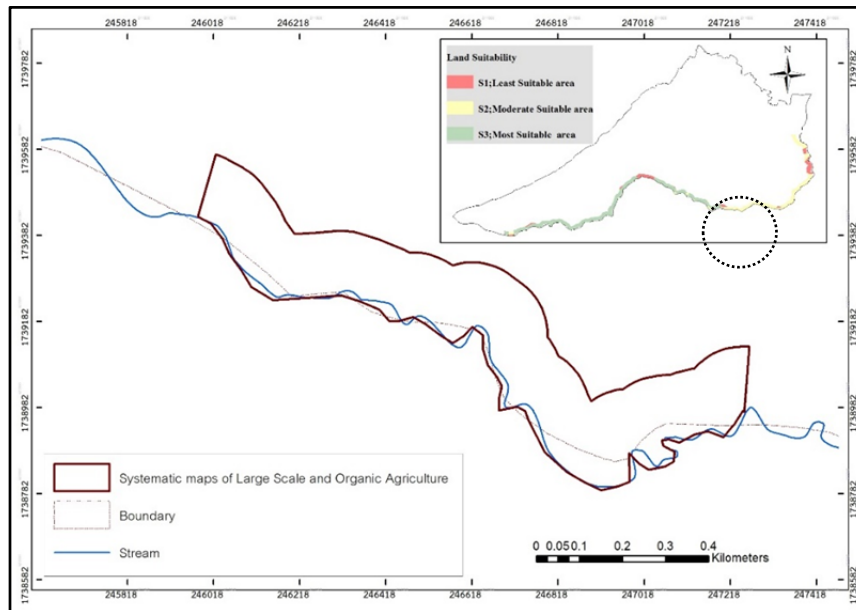**Figure 5** Systematic maps of Large Scale and Organic Agriculture

Figure 6 Systematic maps of Large Scale and Organic Agriculture through SGA approach
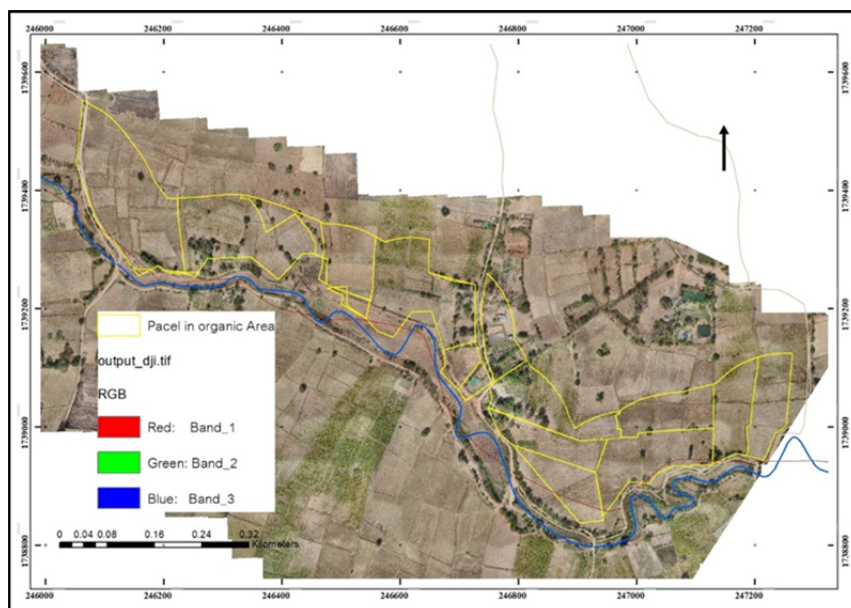

Figure 7 Suitability Large Scale of Organic Agriculture Maps

Conclusions

In accordance with the large scale of organic agriculture plot promoted on the sustainable agriculture concept and international acceptance following the National Organic Agriculture Development Strategy 2017-2021, the organic agriculture pilot plot has been designated in 4 year Development Plan (2017-2021) of Nong Wang Sok Phra Sub-District Administration Organization, Phon District, Khon Kaen Province. However, it is necessary to identify the large scale of agriculture organic plot in terms of land use map with boundary and acceptance of farmers.

This study focused integration of Geoinformatic and Sub-Global Assessment in order to assess the large scale of organic agriculture plot. The study process included 3 main steps; (1) creating the study area and land use map by geo-referencing and classifying land use on the organic agriculture pilot area, as well as confirming through field survey with video record and photography, (2) establishing the preliminary systematic maps of large scale of organic agriculture by criteria weighting and rating scale to analyze for land suitability. The criteria consisted of land use, soil suitability, water resource, transportation, average debt of village, acceptation of member, organic agriculture plot definition. This step consisted of characterizing the physical characteristics and carrying out SGA through focus group and questionnaire, (3) checking such preliminary systematic maps by UAV/ UAV Imagery, and creating parcel maps, then overlay UAV Imagery and parcel maps to establish the suitable large scale of organic agriculture maps.

The existing agriculture organic pilot area of 2000 rai (320 hectare) was downsized to and downsized to 129 rai (20.64 hectare), which was only 15.50% of total organic pilot area. The organic agriculture map created through digital technology (GIS and UAV) and SGA (social mean) has enable acceptance of the members towards organic agriculture. This can be used for expansion of an organic agriculture to meet the designated target of 2,000 rai (320 hectare) of the 4 year plan.

References

[1]   Ministry of Agriculture and Cooperatives. Manual for large-scale agricultural extension system implementation [online]. 2016 [cited 2018, 1 November]. Available: http://www2.oae.go.th/EVA/download/success/large_scale.pdf

[2]   Bureau of Occupational and Environmental Diseases. Report of Occupational and Environmental Diseases 2017 [online]. 2018 [cited 2018, 30 November]. Available: http://envocc.ddc.moph.go.th/contents/view/669

[3]   Board of Agriculture National Organic Strategic Plan for the Development of Organic Ploting 2008-2011 [online] 2017 [cited 2018, 15 November]. Available: http://www.planning.dld.go.th/th/images/stories/section-5/2560/strategy11.pdf

[4]   Millennium Ecosystem Assessment (Program), editor. Ecosystems and human well-being: synthesis. Washington, DC: Island Press; 2005. 137.

[5]   Nong Wang Sok Phra Sub-District Administration Organization, Phon District, Khon Kaen Province. 4 year Development Plan (2017-2021) [online] 2018 [cited 2019, 22 January]. Available: http://www.nongwaeng-kk.go.th/userfiles/lawfile/1134018102432018.doc

[6]   Martínez-Carricondo P, Agüera-Vega F, Carvajal-Ramírez F et al. Assessment of UAV-photogrammetric mapping accuracy based on variation of ground control points. International Journal of Applied Earth Observation and Geoinformation 2018; 72: 1-10.

[7]   Kaewplang S. Evaluating the Number of Suitable Ground Control Points for Topographic Mapping from UAV-derived aerial imagery. SPECIAL ISSUE MAHASARAKHAM RESEARCH CONFERENCE 2018; 14: 245-253.

[8]   Liu W, Zhan J, Zhao F, Yan H, Zhang F and Wei X. Impacts of urbanization-induced land-use changes on ecosystem services: A case study of the Pearl River Delta Metropolitan Region, China. Ecological Indicators. 2019; 98: 228-238.

[9]   Vogdrup-Schmidt M, Olsen SB, Dubgaard A, Kristensen IT, Jørgensen LB, Normander B, Ege C and Dalgaard T., Using spatial multi-criteria decision analysis to develop new and sustainable directions for the future use of agricultural land in Denmark. Ecological Indicators 2019; 103: 34-42.

[10]   Sarath Midatana, Saran S, Ramana KV. Site suitability analysis for industries using gis and multi criteria decision making. ISPRS Ann Photogram Remote Sens Spatial Inf. Sci. 2018; 15: 447-54.