iCBST 2014 International Conference on Business, Science and Technology which will be held at Hatyai, Thailand on the 25th and 26th of April 2014.

Australian Journal of Basic and Applied Sciences, 8(5) Special 2014, Pages: 304-312

AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Biophysical Criteria For Controlling Paddy Land Conversion: Case Study in Aceh, Indonesia and Lessons Learnt for Malaysia

[1]Muhammad Yasar, [2]Chamhuri Siwar and [2]Shaharudin Idrus

[1]*Department of Agricultural Engineering, Universitas Syiah Kuala, Banda Aceh 23111, Indonesia,*
[2]*Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia,Bangi 43000, Malaysia.*

ARTICLE INFO

Article history:
Received 25 January 2014
Received in revised form 12 March 2014
Accepted 14 April 2014
Available online 25 April 2014

Key words:
Conversion of paddy land, food security, sustainable agriculture, biophysical criteria, regional development.

ABSTRACT

Paddy land-use conversion from agriculture to non-agriculture use is a problem that if not addressed seriously, could pose a threat to the safety of food, social condition, economy as well as environment. This research is aimed at identifying the level of reduction of paddy land area due to land-use change and classifying the existing paddy land based on biophysical criteria to enable controlling plan of paddy land from land use change activities. The research area incorporates paddy land area of the administration of Aceh Besar District of Aceh Province of Indonesia. The research is done in a descriptive qualitative manner using the application of Geographical Information System (GIS). The result of this research found that the decrease in the size of paddy land due to land use change from 1978 to 2009 in Kabupaten Aceh Besar is approximately 39.8% or equivalent to 1.28% per year. Based on the outcome of the classification using the existing biophysical criteria, there are 4 paddy land categories namely main land I (9 sub-district), main land II (7 sub-district), secondary land I (5 sub-district) and secondary land II (2 sub-district). A main land is a land area that is proposed to become a permanent area for sustainable agriculture due to its appropriate biophysical criteria. Whereas a secondary land may obtain approval for land use change as long as it is for a more priority and more pressing purpose. Hopefully, this research will be useful as a comparison and sharing of information to tackle the phenomenon of paddy land conversion that also occurred in Malaysia, and also to contribute towards national food security, and sharing of information in the context of South East Asian region and the international community.

To Cite This Article: Muhammad Yasar, Chamhuri Siwar and Shaharudin Idrus., Biophysical Criteria For Controlling Paddy Land Conversion: Case Study in Aceh, Indonesia and Lessons Learnt for Malaysia. ***Aust. J. Basic & Appl. Sci.,*** *8(5): 304-312, 2014*

INTRODUCTION

Paddy land is an agricultural land that is shaped in boxes and bounded by bund and/or water irrigation to stop or allow water to pass through, and is normally planted with paddy. In Indonesia, the role and function of paddy land is very important. Paddy land is not only the focus of efforts to improve paddy only but is also one of people's agricultural system. This means that the paddy land agricultural system is only operated by farmers who are the small communities without intervention by private or big companies. However, in recent years, the rapid increase of development activities has posed a threat to the existence of paddy land due to its conversion into other purposes other than agriculture.

Land use conversion is normally associated with regional development processes, and in fact it can be said that the land use change is a reaction to regional expansion. Part of the land use change to non- agricultural purposes is an inevitable event, that it can be consdered as a dilemma. Utomo *et al*., (1992) defined land use change as a partial or full functional change of a particular area from its original function (as planned) to a function that could cause negative effects to the environment and the land potential itself. Land use change in the meaning of change or usage alteration is caused by a number of factors that are generally incorporate the needs to fulfill the requirements of the people that has increased in numbers and the demand for a better quality of life.

Land use change according to the concept and definition of agricultural statistics (BPS 1988) is a change regarding the use of a paddy land in a certain period. The types of land use change involves: paddy land changes to non-paddy land, paddy land changes to non-agricultural land, non-paddy land changes to paddy land, non-

Corresponding Author: Muhammad Yasar, Department of Agricultural Engineering, Universitas Syiah Kuala Banda Aceh, Indonesia.
E-mail: yasar_stp@ymail.com

paddy land changes to non-agricultural land, non-agricultural land changes to non-paddy land, and non-agricultural land changes to paddy land.

There are tendencies for agricultural land use change especially paddy land becomes non-agricultural land such as for industrial, services and properties purposes in a short time frame. Although there is effort to replace it through the establishment of new paddy land, however, this effort has not been followed with effective control to prevent wider reduction of the quality and quantity of land affected by land use change.

As the development and progressing construction, the strategic of role paddy field is the main staple food of food security, but that is increasingly marginalized in land use. Primacy of economic terms cause the paddy field converted to non-agriculture use which assumed more benefits. This phenomenon usually happens in every developing country. According to Ramankutty *et al*. (2002), international experience shows that rapid growth of the economy is also accompanied by changing of land use from agriculture to industry, infrastructure and property. Countries in East Asia, North America and Europe were loss their agricultural land during economic development period.

In Indonesia, the converted paddy field to non-agricultural use became a highlight of many parties after Director General of Food Crops Production successfully identified more than 160 million hectare of national paddy field converted during period from 1981 to 1999. Siswadi (2009) stated that this activity will increase and estimate to reach 14-15 % per year. This rate is very fantastic if it is compared to same experience at various countries in the world. Xiangzheng *et al*. (2002) indicated that United Stated lost its agricultural land 0.1-0.3 % per year for constructions. Agricultural land in Japan decreased 1 % per year during last three decades for the same interests. The same trend can also be found in South Korea. Most of European countries have experienced the decrease of agricultural land about 1.2-1.5% per year since 1975 to 1995.

Thus far, many people believe that the problem of land use change of paddy land as a common and trivial thing, as only a small portion of the overall food food security problem. The truth to the matter is paddy land has its multifunctional role that when it is lost, it could result in a more complex problem. Pasandaran (2006) reiterates that paddy land agricultural system is a system that is multifunctional in nature. He emphasized three main functions that are interrelated with one another and reqires cohesive relationship to enable the system to exist and function sustainably. Firstly, its function is to support the production of the relevant food, soil, water, planting practices and institution (department) which are important element that are needed in the process of production. Secondly is the conservation function, including the functions to maintain the existing biophysical element, such as land and water chains. When these elements are preserved, then only its conservation function works effectively. The third function is the conservation and inheritance of traditional values, including the social life and the traditional knowledge (local wisdom) that helps arrange relationship among the people and between the people and the environment.

The intervention of external factors such as investment programs that solely focus on economic growth will disturb the cohesiveness of the existing multifunctional relationship. Protecting paddy land agricultural system is not an easy task to undertake because there exists priority challenges between individuals who want to utilize the paddy land for the purposes that can be considered as having a higher economic returns that is in line with the benefits of the communities to ensure the sustainability of the existing paddy land system.

This study is aimed at identifying the level of reduction of paddy land due to conversion and the classifiation of existing paddy land based on the biophysical criteria for the purpose of controlled plan of paddy land from land use change activities. Hopefully, this research will be useful as a comparison and sharing of information to tackle the phenomenon of paddy land conversion that also occurred in Malaysia, and also to contribute towards national food security, and sharing of information in the context of South East Asian region and the international community.

MATERIALS AND METHODS

Areas of Study:

This study is undertaken in Aceh Besar District of Aceh Province, Indonesia (fig. 1). The location of Aceh Besar borders the Straits of Malacca/Kota Banda Aceh on the north, Aceh Jaya District on the south, Pidie District on the east and Indian Ocean on the west. Geographically, Aceh Besar District is located between 5.2^0 – 5.8^0 N and 95^0 – 95.48^0 E with the overall regional size of up to 2,974.12 Km^2 or 5.8 % of the size of Aceh Region. This district is situated between 0 - 1,500 meters over sea level. The bigger portion of it (42.65%) is situated between 100 - 500 meters over sea level. This region is comprised of plains, hills and mountains.

Kabupaten Aceh Besar is one of paddy production centre districts in Aceh Region, Indonesia. As a main commodity, paddy is produced from kabupaten that owns paddy land size of 30,421 hectares, reaching up to 10.31% of the overall paddy production of Aceh Region.

Its location borders the regional capital city of Banda Aceh, making the location of this district to be extremely vulnerable to the possibility of land use change, especially paddy land from the usage of agriculture to usages other than for agriculture. This is evidenced from the statistical data of the potential of Nanggroe Aceh

Darussalam (BPS NAD 2008) that shows that Aceh Besar District is a district that has the biggest potential for land use change in Aceh Region whether for the purposes of housing (settlement), industry, stores or other usages. Furthermore, this kabupaten which is located near the ocean is also recorded as a region that has experienced soil damage after the tsunami tragedy on 24 December 2004.

Fig. 1: Map of study area

The Department Distan TPH Aceh Province (2009) has recorded that approximately 3,131 hectares of paddy land in District of Aceh Besar has experienced heavy deterioration, while 1,528 hectares has experienced medium deterioration and no paddy land has experienced small deterioration. The bigger portion of the heavily deteriorated paddy land has since experienced improvement and rehabilitation process, but there is still plenty of paddy land that has experienced land use change due to the needs for land for relocation of the victims of the tsunami tragedy. This is further worsened by the traumatic experience of the community to reside on the shore as they prefer to opt for a living in areas that are much further away from the ocean. To fulfil this requirement, paddy land is considered as the most suitable due to its plain topography, in addition to its cheaper value.

Research Methodology:

This research is done descriptively by collecting some relevant information related to the reduction of paddy land that is happening in Aceh Besar District, Aceh Province, Indonesia. Data is obtained through the relevant government departments comprising official reports, land use map, topography map and satellite images. Direct field observation is also conducted to ascertain the situation.

Paddy land size reduction due to land use change activities is identified through overlay and topographic map digitisation 1:50,000 (BAKOSURTANAL, 1978) and satellite image (Landsat-TM year 2000 or 2009) with visual classification method using ArcGIS 9.3. Whereas paddy land biophysical condition is classified based on Table 1 that is the Paddy Land Quality Criteria as a base for the control of land use change of paddy land (shapefile and polygon) that can be used as the base for determining the areas that must be protected from land use change efforts.

Paddy production in a paddy land region or area according to Abdurrahman (2005) is influenced by three biophysical factors namely: productivity level, planting intensity and irrigation status. The three factots is closely interrelated. Based on the combination of the three factors that become the paddy land biophysical parameters, the quality of the paddy land can be classified into 8 classes, and later on is mediated into 4 classes namely: (1) main paddy land I, (2) main paddy land II, (3), secondary paddy land I and secondary paddy land II.

Based on its status, irrigation can be differentiated into 3 classes namely paddy land with technical and semi technical irrigation, medium irrigation and paddy land with landfalls. According to definition by Badan Pertahanan Nasional (BPN), irrigated paddy land is paddy land whereby its water resource is originated from other areas with water channeling that is purposely built for that. Water from technically irrigated paddy land is

originated from dams or lakes and is channelled through primer channel that is later on distributed into the secondary and tertiary channels through water controlling building.

Technical and semi technically irrigated paddy land is differentiated based on its chains management system. It is called technically irrigated when the whole irrigation network is monolised and maintained by the government, whereas the semi technically irrigated system is when the government only manages water controlling building to arrange and measure water intake. It is called medium irrigated when the water resources originated from other areas (generally from *mata air*) and its chanelling is made in a medium manner by the local farming communities, without permanent buildings. It is called rainfalls paddy land when the whole water resource is obtained from local rainfalls.

Croping index or also mentioned as planting intensity can be differentiated into 2 classes, that is CI>2 and CI<2 planting times a year. The CI categorisation is done with the consideration that paddy land irrigation would mainly enable paddy to be planted twice or more times a year. Paddy land that has CI<2 planting times a year is generally paddy land with rainfalls or part of it can only be planted once a year due to insufficient water resource. Especially those that are located at the end of primer channel and far away from water resource.

Table 1: Criteria of paddy field quality

No	Status of Irrigation	Cropping Index (CI)	Productivity (ton/Ha)	Grade Land	Zone
1	Technical/Semi-technical	≥2 times planted	≥4,50	Main Paddy Land I	Protected
2	Technical/Semi-technical	≥2 times planted	≤4,50	Main Paddy Land II	Protected
3	Technical/Semi-technical	≥2 times planted	≥4,50	Main Paddy Land II	Protected
4	Technical/Semi-technical	≥2 times planted	≤4,50	Main Paddy Land II	Protected
5	Simple/rainfed	≥2 times planted	≥4,50	Main Paddy Land II	Protected
6	Simple/rainfed	≥2 times planted	≤4,50	Secondary Paddy Land I	Limited Conversion
7	Simple/rainfed	≥2 times planted	≥4,50	Secondary Paddy Land II	Limited Conversion
8	Simple/rainfed	≥2 times planted	≤4,50	Secondary Paddy Land II	Limited Conversion

Source: Modified from Abdurrahman *et al*. (2005) and BPN (2004)

To achieve high production level, plants require optimum growing factors. All those factors are generally related to climate and land or soil. A particular soil that can provide high production can be considered productive. This ebility is called land or soil productivity. The level of productivity can be divided into two classes, namely > 4.50 ton and <4.50 ton of rice per hectare. This classification is determined based on the level of average paddy land productivity in Indonesia that achieved 4.50 ton per hectare.

RESULT AND DISCUSSION

Reduction of Paddy Land Size:

According to the Government's report that is by the Department of Agriculture, Food and Horticulture (Distan TPH) District of Aceh Besar (2009), it has been identified that there is a 2.27 % reduction of paddy land. However, the statement did not explain the periodical changes of the land size. The outcome of the overlay and the digitisation of topographic map as well as the interpretation of the satellite image have indicated that the change is indeed substantial. In 1978, it could be seen that the size of the paddy land in Kabupaten Aceh Besar was still huge and intact. The condition has changed drastically in 2000. The outcome of some research has identified the reduction of paddy land size by 34.88 % or equivalent to 1.58 % per year. This use change of the paddy land continued over time in the preceeding years. Until 2009, the district has lost 39.87 % or equivalent to 1.28 % of land per year.

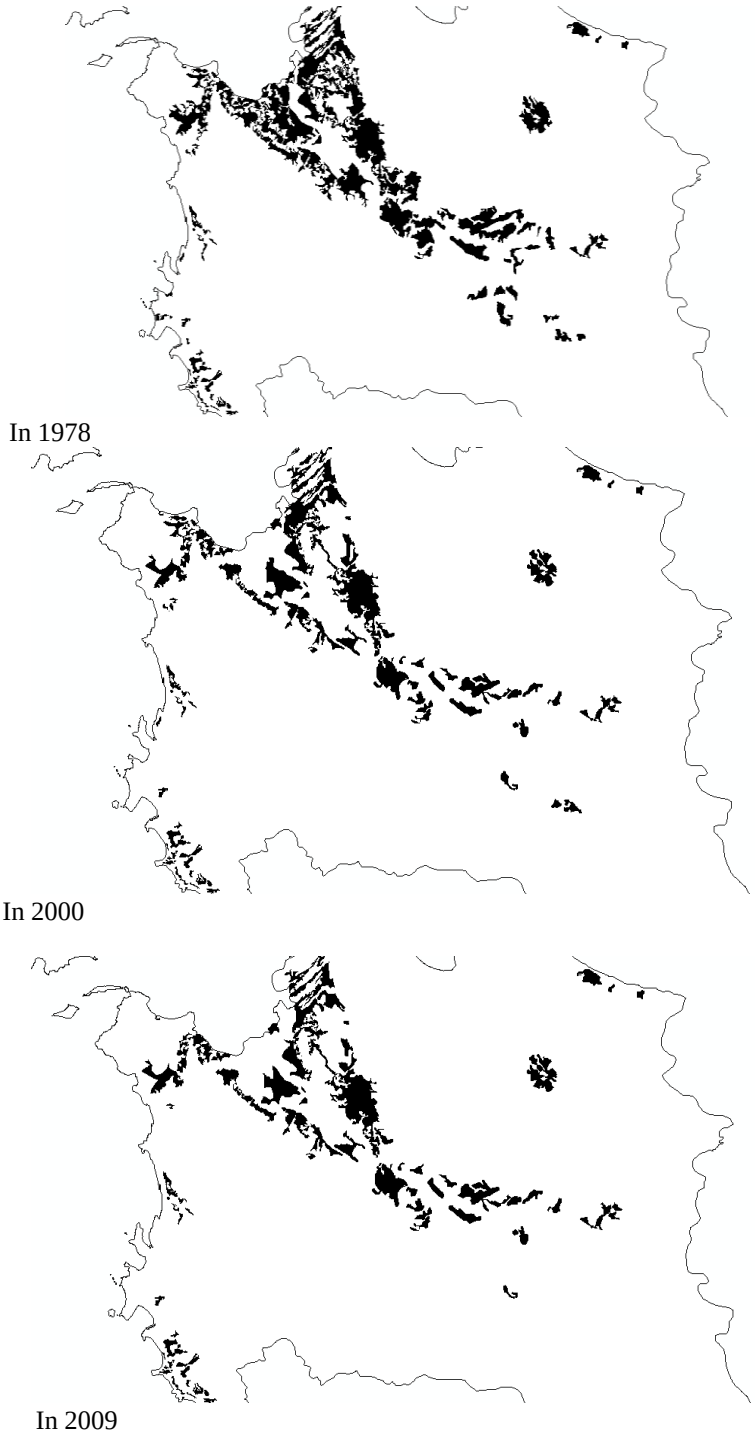

Table 2: Percentage Reduction of Paddy Land Conversion and Land Size Base on GIS Digitisation

	Paddy Land Size (Ha)			Reduction of Paddy Land (Ha)			Percentage (%)		
Year	1978	2000	2009	1978 - 2000	2000 - 2009	1978 - 2009	1978 - 2000	2000 - 2009	1978 - 2009
Value	2,005,000	1,328,091	1,231,227	7677	1096	8773	34.88	7.65	39.87

This statement is actually a threat to the stabilisation of food resources and the multifunctional role of paddy land. Therefore, strategic efforts need to be immediately undertaken so that the reduction of the paddy land size can be controlled, to the point that whatever effects there might be can be effectively anticipated.

Paddy Land Classification:

The research result indicated that there are four categories of paddy field in Aceh Besar district. They are:

1. The Main Paddy Land I:

The main paddy land is paddy land which has reliable biophysical criterion. It has enough water resource and equipped by technical irrigation system/semi-technical, so that it can be planted paddy more than or equal to twice in a year, therefore it can reach level of productivity over or equal to 4.5 ton/Ha. This land is the zone that must be protected, kept and maintained its conservation from conversion.

The zone which is classified in this category consists of 9 districts, they are: Blang Bintang, Darussalam, Indrapuri, Ingin Jaya, Kuta Baro, Kuta Malaka, Montasik, Simpang Tiga, and Suka Makmur. Seven of them were irrigated by technical irrigation, whereas 2 of the rest (Kuta Baro and Kuta Malaka) are still irrigated by semi-technical irrigation. All of them in these districts were planted paddy a number of 2 times in a year.
The level of productivity which reached at this zone is around 4.9 ton/Ha-5.2 ton/ha. The zones that have level of productivity 5.2 ton/Ha consist of seven sub districts, they are : Blang Bintang, Darussalam, Indrapuri, Ingin Jaya, Kuta Baro, Montasik, and Suka Makmur, whereas 2 of the rest are Kuta Malaka and Simpang Tiga have level of productivity 5.1 ton/Ha dan 4.9 ton/Ha.

Table 3: Zone of the Main Paddy Land I

No	Name of District	Irrigation Status	Cropping Index	Productivity
1	Blang Bintang	Technical	2	5.2
2	Darussalam	Technical	2	5.2
3	Indrapuri	Technical	2	5.2
4	Ingin Jaya	Technical	2	5.2
5	Kuta Baro	Semi-technical	2	5.2
6	Kuta Malaka	Semi-technical	2	5.1
7	Montasik	Technical	2	5.2
8	Simpang Tiga	Technical	2	4.9
9	Suka Makmur	Technical	2	5.2

2. The Main Paddy Land II:

The Main Paddy Land II is considered as potential paddy land, but it is only from behaving the three of biophysical criteria, there is one shortage compared to the main paddy land I. The shortage is possible to reach two with requirement, like irrigation status as technical or semi-technical. This is caused by cropping index and the productivity is an outcome factor from irrigation function. In general, if irrigation system was enough, cropping index and productivity will easier enhance.

There are four possibilities of paddy land which includes in category to the main paddy land II. They are:

a. Land which its irrigation status is technical or semi-technical and planted the paddy more than or equal to 2 times per year, but result of its production is less or equal to 4.5 ton/Ha.

b. Land which its irrigation status is technical/semi-technical and result of its production more than or equal to 4.5ton/Ha, but it is only planted less than or equal to 2 times per year

c. Land which its irrigation status is technical/semi-technical, but it is planted less than or equal to 2 times per year and its production is also less than or equal to 4.5 ton/Ha.

d. Land which its irrigation status is simple/rain fed, but it can be planted more than or equal to 2 times per year and its production is more than or equal to 4.5 ton/Ha

This land category must also be protected, kept and maintained its conservation from threat of conversion. The zone that includes 7 subdistricts namely Darul Imarah, Darul Kamal, Krueng Barona Jaya, Kuta Cot Glie, Lembah Seulawah, Lhoong, and Seulimum.

Among 7 sub districts which classified into the main paddy land II are 6 sub districts which its irrigation status is simple/rain fed, but they can be planted 2 times per year and result of its production is from 4.9 ton/Ha to 5.2 ton/Ha. Whereas Krueng Barona Jaya sub district had its irrigation status semi-technical with level of reaching production 4.9 ton/Ha, but it can only be planted 1 time per year.

Table 4: Zone of the Main Paddy Land II

No	Name of Sub district	Irrigation Status	Cropping Index	Productivity
1	Darul Imarah	Rain fed	2	4.9
2	Darul Kamal	Rain fed	2	4.9
3	Krueng Barona Jaya	Semi-technical	1	4.9
4	Kuta Cot Glie	Rain fed	2	5.1
5	Lembah Seulawah	Simple	2	5.1
6	Lhoong	Simple	2	5.1
7	Seulimum	Simple	2	5.1

The phenomenon above shows that the zone of paddy field at 6 sub districts is basically land with level of an adequate rainfall and water resource. It is only caused by them, so the zone has not yet a facility of adequate irrigation.

3. The Secondary Paddy Land I:

The Secondary Paddy Land I is the paddy field which has simple/rain fed irrigation and has cropping index (CI) more than or equal to 2 time per year or level of productivity more than or equal to 4.5 ton/Ha. This type of paddy land has only one obstacle. Nevertheless, it does not mean that the paddy field which includes in this category can be converted. Similar to the main paddy land II, the secondary paddy land I is also type of paddy field which has potential for paddy planting development, but it is still needed a greater effort for biophysical condition improvement. This type of paddy land is estimated that the paddy field is arable with availability of an adequate water resource, but it is only not yet of optimum using and development.

Table 5: Zone of the Secondary Paddy Land I

No	Name of sub district	Irrigation Status	Cropping Index	Productivity
1	Kota Jantho	Rain fed	1	4.5
2	Lhoknga	Rain fed	1	4.9
3	Peukan Bada	Rain fed	1	4.8
4	Baitussalam	Rain fed	1	4.6
5	Mesjid Raya	Rain fed	1	4.5

The zone which classified in the secondary paddy land I is 5 sub-districts. They are Baitussalam, Kota Jantho, Lhoknga, Mesjid Raya and Peukan Bada. All of them are arable paddy field with cropping index 1 time per year, but level of its productivity is highly classified. That is from 4.5 ton/Ha to 4.9 ton/Ha.

4. The Secondary Paddy Land II:

The secondary paddy land II can also be called as land which has low biophysical criterion. This land only has not irrigation system, so that process of paddy production depends on rainy season as resource of water availability, because of that capability of plant and production are also low.

The zone which includes in this category is Leupung and Pulo Aceh sub-districts. Geographically, both of them are located at coastal area. Even Pulo Aceh sub-district is island sub-district which separated by sea.

Table 6: Zone of the Secondary Paddy Land II

No	Name of sub-district	Irrigation Status	Cropping Index	Productivity
1	Leupung	Rain fed	1	0
2	Pulo Aceh	Rain fed	1	0

Both Leupung and Pulo Aceh, They are not included in produced zone of mainstay paddy in Aceh Besar district. Many zones of paddy field which is damaged by tsunami disaster, because its potential is less well, so that this zone is less become as main priority in order to recover the paddy field.

The land which is called as marginal land is not prohibited if it is converted to non-agricultural use, but this land does not become as converted activity target. Because of that construction in non-agricultural sector can be directed to this zone.

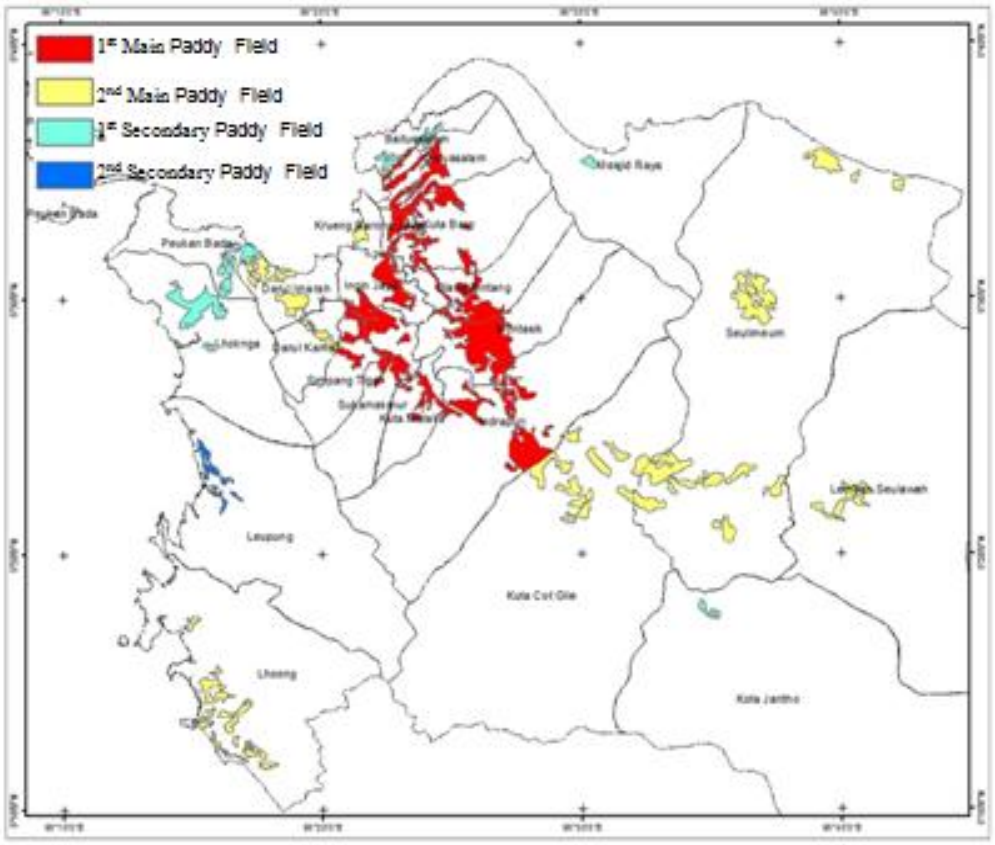

Fig. 2: Classification of paddy land base on biophysical criteria

Paddy Land Conversion in Malaysia:

In Malaysia, to ensure the level of self-sustained rice as the national food security, the Government has identified 8 granary areas located at Integrated Agriculture Development Areas (IADAs) in Peninsular. They are Muda Agriculture Development Area (MADA), Kemubu Agriculture Development Area (KADA), Kemasin-Semerak IADA, North West Selangor IADA, Penang IADA, Seberang Perak IADA, North Terengganu IADA and Kerian-Sungai Manik IADA . Even for these areas, the land use change activities for the purpose of non-agricultural development or non-paddy agriculture are inevitable. From the perspective of the size of the diminished paddy land area, Kemasin Semerak IADA was identified as the granary area with the highest rate of loss. Almost half of the area has experienced land use change that is a reduction of 5,613 hectares or 52.65% of its total size. This is followed by Kerian-Sungai Manik IADA with 3,270 hectares or 10.90%, and KADA with 1,990 hectares or 6.32% from its total area.

In contrast, from the perspective of the size of the states that were experiencing the loss of paddy land, there were two areas with increasing size of land losses. The two areas were North West Selangor IADA (BLS) and Penang IADA which recorded an increase of 831 hectares (4.56%) and 364 hectares (3.66%) respectively. Although the increase of the land lost is not compatible with the total diminished land in other areas, at least it has replaced part of the land that was lost. Overall, the lost of paddy land in Peninsular Malaysia according to the States and granary areas was 1.47% and 0.34% respectively.

Conclusion:

Land-use change of paddy land to the non-agricultural use is a phenomena that has become a dilemma and it is also a logical reaction towards development activities in Indonesia and Malaysia. Maintaining the existence of paddy land is not only important in stabilising food supply, but it also covers the needs of many other developmental aspects as paddy land is multifunctional in nature. Serious efforts to manage paddy land use change is desperately needed. The dating of coordinated and integrated land together with the arrangement of holistic and comprehensive land use change control policy and strategy need to be immediately established. For this purpose, the outcome of this research may be used as a matter for consideration in planning regional development with a vision of sustainable environment.

ACKNOWLEDGEMENT

The author would like to express gratitude and highest appreciation to all who have assisted in the

successful completion of this research, especially to Prof. Emeritus Chamhuri Siwar who has awarded Graduate Research Assistant (GRA) to the lead author from a project on food security (LRGS/TD/2011/UPM-UKM/KM/04) which help to sustain part of his studies in UKM.

REFERENCES

Abdurrahman, A., Wahyunto, & R. Shofiati, 2005. Kriteria Biofisik Dalam Penetapan Lahan Sawah abadi di Pulau Jawa. http://www.pustaka-deptan.go.id/publikasi/p3244052.pdf. [Accessed:December, 2009]

BPN Sulsel, 2004. Laporan Tahunan. Badan Pertanahan Nasional (BPN), Provinsi Sulawesi Selatan.

BPS., 1988. Konsep dan definisi baku statistic pertanian (KBSP), CV.Nario Suri, Jakarta

BPS NAD., 2008. Statistik Potensi Desa Nanggroe Aceh Darussalam. Biro Pusat Statistik Nanggroe Aceh Darussalam. Banda Aceh.

Pasandaran, E., 2006. Alternatif Kebijakan Pengendalian Konversi Lahan Sawah Beririgasi di Indonesia http://www.pustaka-deptan.go.id/ publikasi/ p3254062.pdf [Accessed: August, 2009].

Ramankutty, N., J.A. Foley and N.J. Olejniczak, 2002. People on the Land: Changes in Global Population and Croplands during the 20th Century. AMBIO: A Journal of the Human Environment., 31: 251-257.

Siswadi, 2009. Kemandirian Pangan vs Konversi lahan. Harian Umum Pelita. Opini, edisi Senin.

Utomo, M., E. Rifai & A. Thahir, 1992. Pembangunan dan Alih Fungsi Lahan. Lampung: Universitas Lampung.

Xiangzheng Deng, Jikun Huang, Scott Rozelle and Emi Uchida, 2005. Cultivated and Conversion and Potential Agricultural Productivity in China. http://iis-db. stanford. edu/pubs /21642/ cultivate_ land_ conversion_ and_bioproductivity _final_version_draft3.pdf. [Accessed: November, 2011]