Sustainability status of rice fields in the rice production center of Citarum Watershed

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Abstract. Rice field has multifunctions, including maintaining the stability of hydrological functions (Citarum Watershed), prevent flooding, decrease erosion, provide employment, providing a unique and rustic appeal and defend the values of rural culture. Citarum Watershed located in West Java Province, where West Java has the largest contributed national producer of rice as much as 12,083,162 tons of national rice yields by 71,279,709 tonnes. Rice field in Citarum watershed has not sustainable status due to the high rate of land conversion, policy directives are need to clarity of spatial land use with regional regulations to control the rice field conversion, implementation of Sustainable food agricultural land which are owned by the government, opening transmigration area based on paddy field, develop many products from one product by utilizing waste from blue economy concept, so the paddy fields is still needed for other industry as input production

Key Words: rice field conversion, multi dimensional scalling, sustanability analysis, productivity.

Introduction. Wetland is the producer of staple foods, especially rice for the people of Indonesia, and should be maintained and utilized as much as possible for the welfare of the community. In addition to functioning as a producer of grain, rice fields have broader functions, including maintaining the stability of hydrological functions Watershed (DAS), preventing flooding, decreasing erosion, providing employment, providing uniqueness and attractiveness of the countryside and maintaining the cultural values of the countryside (Irawan 2001).

Of all the regions in Indonesia, West Java has contributed to be the largest national producer of rice in 2013 ranks first nationally. Paddy fields in West Java, have high productivity and supply rice production as much as 12,083,162 tons of rice yield amounted to 71,279,709 tons nationwide (CBS 2014a). Where Citarum gave contributions to the West Java rice with as much as 18,10%, and west Java gave contributions to the national food production 16,95%. Wetland conditions in Citarum from year to year narrowed due to conversion to non-agricultural use, while the expansion of the wetland through paddy printing were even more limited due to budgetary constraints and the limited development of land and water resources.

If there is no immediate anticipation of the wetland conversion rate, at one point it is feared that Citarum will lose its function as the center for national rice production. Various regulations have been issued by the Government to limit the conversion of paddy fields. Law Integration of Law 41 of 2009 and its derivatives regulation into the Short-Term Development Plan and Medium - provincial district and the city has not been fully carried out. Likewise, Goverment Regulation 12 of 2012 on Agricultural Land Protection Incentives Sustainable accomodation is yet in basic needs of farmers to not sell their farms.

It is realized that the task of protecting the system of rice fields is not an easy thing to do, considering the conflict of interest between individuals who want to use rice

fields for purposes that are considered to have a higher economic value to the interests of the community or nation to sustain the existence of the existing system of rice fields (Pasandaran 2006).

The purpose of this study include: 1) knowing the leverages factors causes to rice fields conversions, 2) knowing the sustainability status value of the rice fields.

Material and Method. This research was conducted in August 2013 through June 2014, at 4 districts in Citarum that were representing the watershed upstream portion (Bandung regency), DAS Middle section (West Bandung and Purwakarta) as well as the downstream watershed (Karawang). The total area of the four districts covered 5793.15 km^2 and were divided from an area of 1762.39 km^2 of the Bandung Regency (CBS 2014b), West Bandung Regency area of 1305.77 km^2 (CBS 2014c), covering an area of 971.72 km^2 of Purwakarta (CBS 2014d) and Karawang area of 1.753.27 km^2 (CBS 2014e). The rice field area of the four counties experienced a decline in which 2000 has an area of wetland covering an area of 163,203.92 hectares and in 2011 to 153,486.89 hectares (CBS 2014a).

The research method used an analysis of Multi Dimensional Scaling (MDS), assessing factors (Kavanagh & Pitcher 2004) that have been designed from each dimension (social, economic, ecological, technological and infrastructure and legal and institutional) to provide scoring. Respondents were drawn from expert stakeholders (government agencies, farmers' groups, academics and businesses) of the four districts. Furthermore, the results of the expert assessment will generate a leverage factor of each dimension of the value of sustainability that will describe the position of the sustainability status of each dimension in which it was are divided into four categories of sustainability.

Scale sustainability index functions of wetland resources have hosed 0-100%. If the system study has an index value of more than 50% then the functions of land resources in these fields are sustainable, and vice versa if it is less than 50% then the system is not sustainable. However, in this study the authors tried to make the four categories of the sustainability status based on the basic scale, as presented in Table 1.

Table 1

Status category of sustainable functions farm field sources based on index value

Index value	*Category*
0 - ≤ 25	Unsustainable
25 > Index ≤ 50	Lack Sustainable
50 > Index ≤ 75	Sustainable
75 > Index ≤ 100	Very sustainable

Technical ordination in MDS based on the Euclidean distance, which in dimensional space can be written as (Pitcher & Preikshot 2001):

$$d = \sqrt{(|X_1 - X_2|^2 + |Y_1 - Y_2|^2 + |Z_1 - Z_2|^2 + \cdots)}$$

Ordination an object in MDS, approximated by regressing distance Eucledien (dij) from point i to point j, with the origin (σij) as the equation (Pitcher & Preikshot 2001):

$$d_{ij} = \alpha + \beta\delta_{ij} + \varepsilon$$

The technique used to regressing the equation is algorithm ALSCAL (Alder et al 2000). ALSCAL method of optimizing the distance squares (distance squared = dijk) to the square of the data (point initial = oijk), which is in three dimensions (i, j, k) written in a formula called S-Stress following:

$$s = \sqrt{\frac{1}{m}\sum_{k=1}^{m}\left[\frac{\sum_i\sum_j\left(d_{ijk}^2 - o_{ijk}^2\right)^2}{\sum_i\sum_j o_{ijk}^4}\right]}$$

Distance squared weighted by distance Euclidean (Alder et al 2000):

$$d_k^2 = \sum_{a=1}^{r} W_{ka} \left(X_{ia} - X_{ja}\right)^2$$

Results and Discussion. Based on the existing extents of land areas, the higher pressure leads to reduced wetland area. The decline in the condition of wetlands will describe the current sustainability status, and also in which these pressures are caused by a wide variety of factors that exist. In this research, we will see the leverage factors and sustainability status value in five dimensions.

Social dimension. Based on the analysis of MDS, social dimension is strongly influenced by the agricultural extension with scale factor values of 2.35 and agricultural labor with a value of 2.20. Both of these factors need to be considered from the social aspects, thus greatly determine the future sustainability of the wetland. Agricultural extension is a vital wetland that's related to understanding the owner of the importance of wetland values in the long term as well as the knowledge management to increase the yield of rice production that is more optimal, both in terms of seed and time cropping patterns. Counseling in addition to a personalized approach of providing an understanding beforehand, then by way of group discussions. Salampessy (2012) shows that a group discussion after understanding the conditions will be a more effective method by forming meetings and group discussions so that education is not a one-way only. Another factor, the superior seeds to produce good rice production and an increase in the Investment Index (IP) optimize the timing of land management. Various factors forming the social dimension is shown in Figure 1.

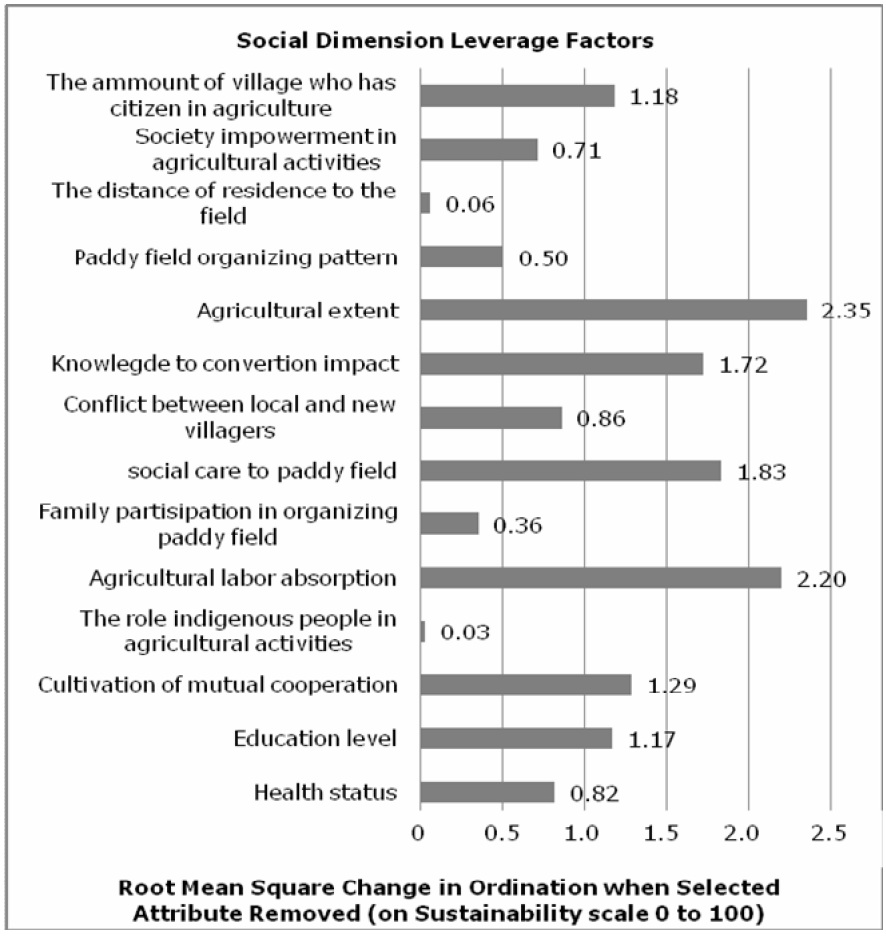

Figure 1. Factors in the social dimension.

The social conditions are still very good so that the status of the social dimension of sustainability is at 55.91. Entering the category is the quite sustainable, but it needs to be maintained with due regard to the sustainability of the lever factor. Overview of the status of sustainability is in Figure 2.

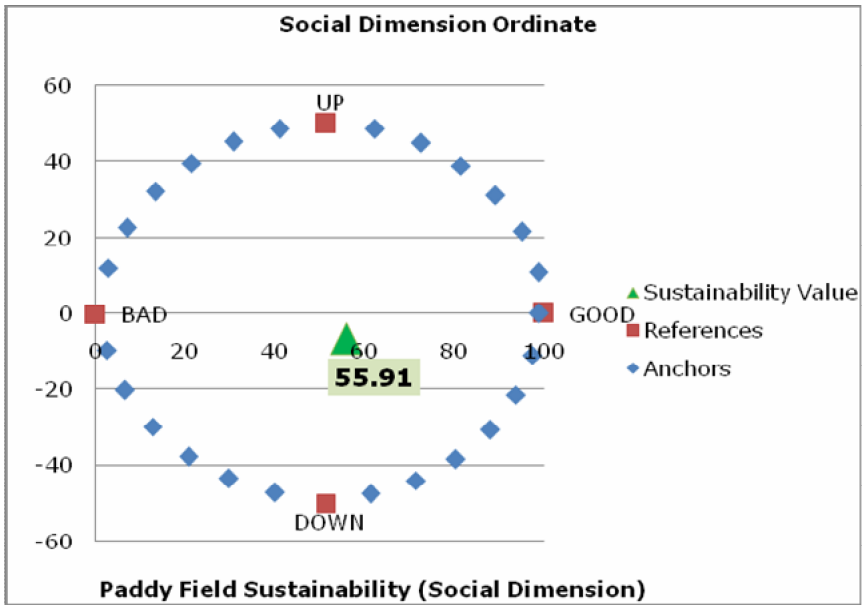

Figure 2. Social dimension sustainability status.

Economic dimension. In the economic dimension of the factors that influenced the presence of the wetland rice production center in Citarum include the number of agricultural labor as the driving function of the existing wetland with a value of 3.26 and a factor for the number of market access with a value of 2.85. The amount of labor farmers are diminishing, especially when the successors of agricultural land managers are a few. Young people including children of farmers do not want to work like their parents and an economic overview shows that farmers do not have a good future. On the other hand, it shows that because the perception of working in an office or company is better even though factory workers and janitor of an office are also better than as farmers. Because the income from farming is not considered a routine and only at harvest time, the income of farming results can be greater than in a factory. While factors for the amount of market access is the need for further market reach and not only local markets so as to guarantee the stability of prices, and production targets required farmers to increase yields farming. Market reach is also associated with a short marketing chain but too much involvement of middlemen minimalizes the price of rice at the farm level. The factors forming the economic dimension are shown in Figure 3.

The current status of the sustainability of the economic dimension in the center of rice production in Citarum with a value of 56.30 enters a category that is quite sustainable. It nevertheless remains a concern as it approaches the limit value of 50 as less sustainable categories. Picture position on the economic dimension of sustainability status is shown in Figure 4.

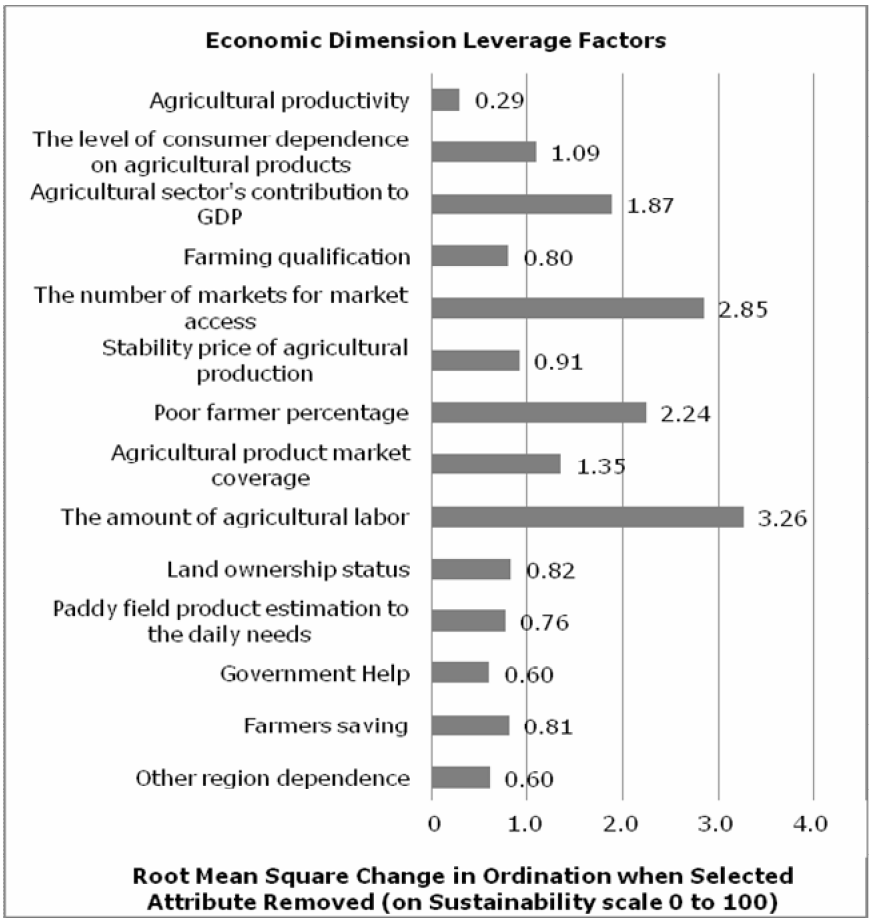

Figure 3. Factors in economic dimension.

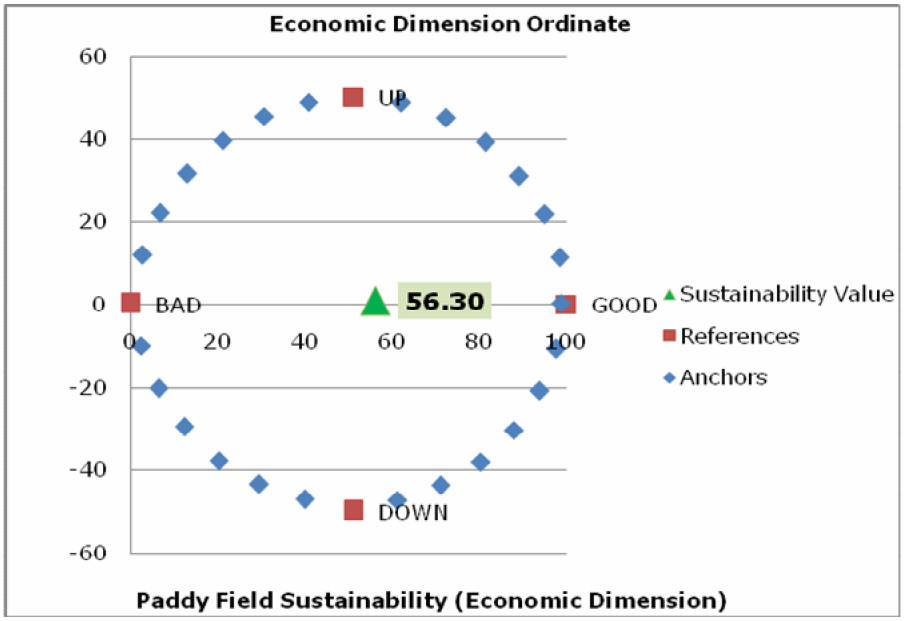

Figure 4. Economic dimensions of sustainability status.

Ecology dimension. Ecological aspects in Citarum are still seen good from the sustainability status of an existing wetland. Factors influencing it are a high pressure with a value of 4.24 as well as the use of superior seeds with a value of 3.93. The pressure of land used from other usage is dominated by changes in the use of land for industrial and residential purposes. Karawang has quite a high industrial activity that is close to Bekasi and Jakarta. This is the Industrial Zone as well as a direction of industrial area

development of Jakarta and Bekasi. While the use of residential land is also factor causing pressure on the wetland, this makes activity of the residential-housing construction higher. On the other hand, the interest of farmers will need a huge cost in a short time and the bidding price of the land from those developers is drawn by landrent from wetland to other land uses. Other sustainability field status constructing factor is to use seeds that have a high production yield. Description of the factors on the ecological dimension is shown in Figure 5.

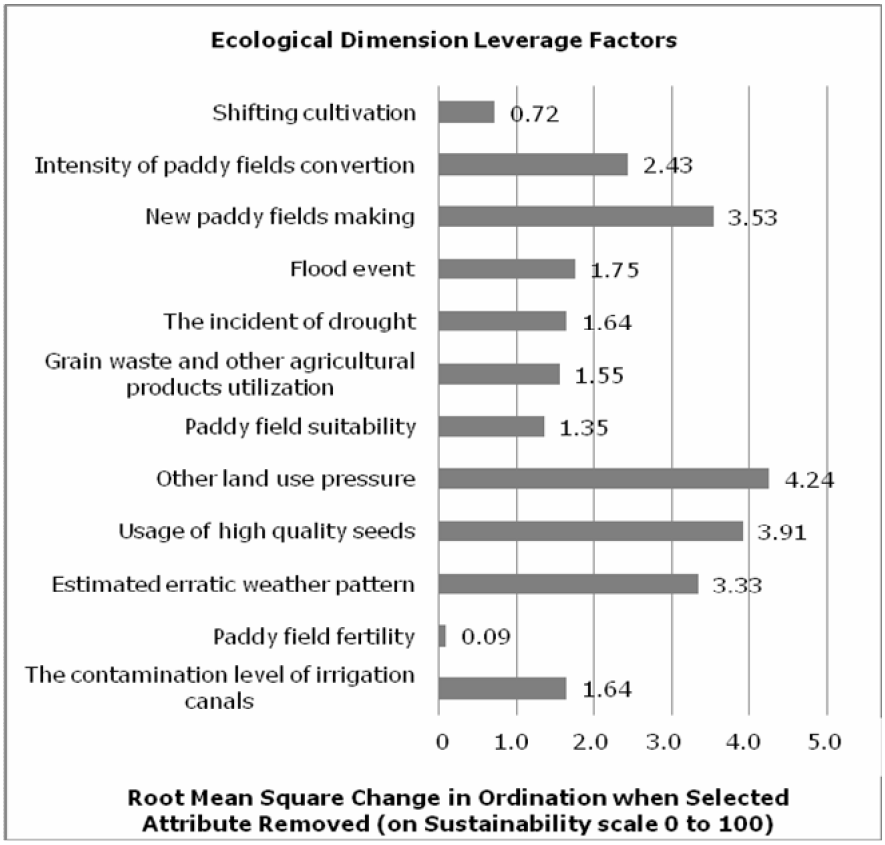

Figure 5. Factors on ecological dimension.

The sustainability status of the ecological dimensions of 57.66 goes on quite a sustainable criteria in which this condition was better than the previous social and economic dimension. The status position of ordinal ecological sustainability dimensions is shown in Figure 6.

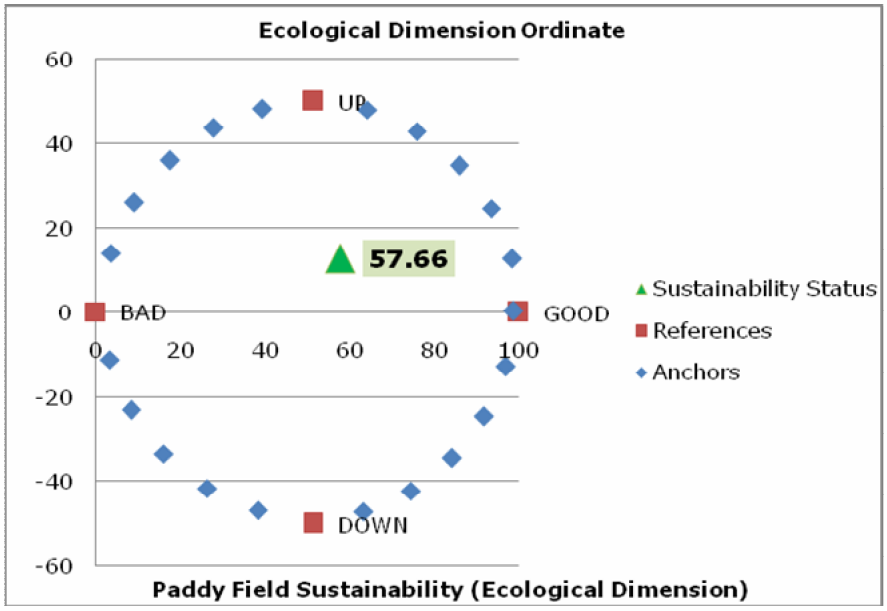

Figure 6. Dimensions of ecological sustainability status.

Infrastructure and technology dimension. Factors on the infrastructure and technology dimension are conditions in which the constructing factor inputs and the use of products were derived from agricultural products. These saprodi conditions such as farm implements that most farmers are still not optimal in the uptake of appropriate technologies as well as fertilizer and pesticides during the application of organic fertilizer are still considered to be more expensive than artificial fertilizers. On the other hand, the added value of agriculture has not been in a lot of derivative products because they can not take advantage of technology and innovation and it is not optimal in the farming community to utilize waste and products derived from agricultural products. Value of constructing factors are based on the analysis of the condition of MDS farming inputs of 3.45, and the use of products of farm crops amounted to 3.37. Picture of the value of the factors in the infrastructure and technology dimensions are shown in Figure 7.

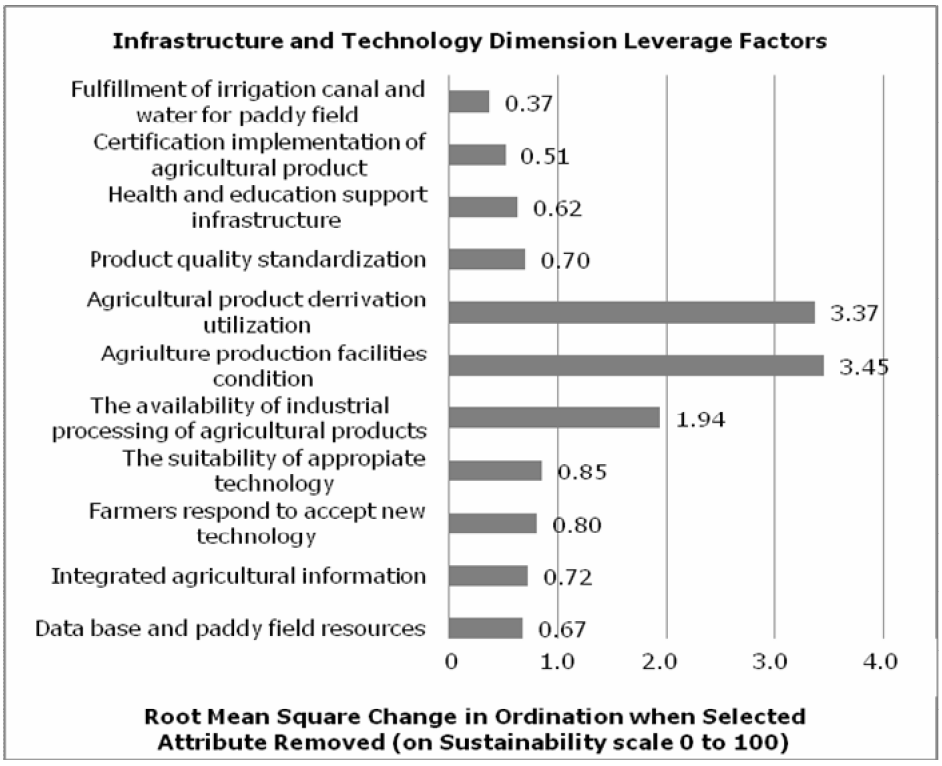

Figure 7. Factors in the dimensions of infrastructure and technology.

The infrastructure and technology dimension is the dimension that is very vulnerable because of its sustainability status that entered the category of less sustainable with a value of 45.93, so as to enhance the sustainability status of the need to consider the existing construction factor. The position of the status of sustainability in this dimension is as shown in Figure 8.

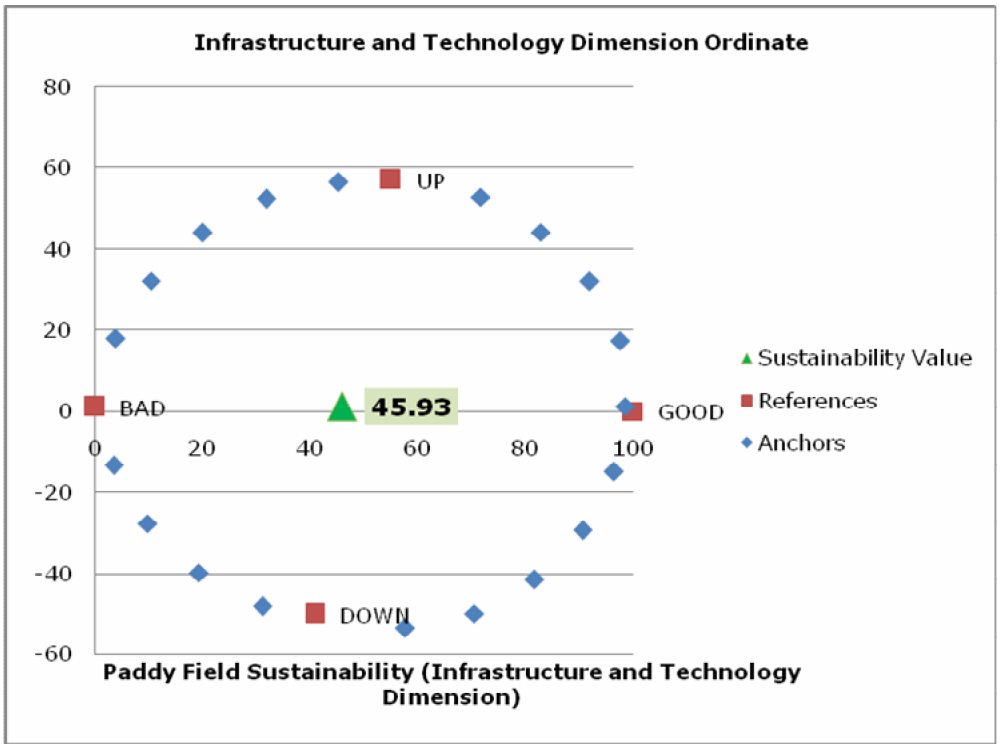

Figure 8. Status dimensions of infrastructure sustainability and technology.

Legal and institutional dimension. On the the legal and institutional dimension, factors that influence the sustainability of dimensions are a spatial clarity with a value of 6.99 and counseling on the effects of wetland conversion with a value of 5.11. The application of spatial policy is sufficient but there is a need of wetland conversion for the purposes of development of the local government, so that the layout is not a problem but it will reduce the area of wetland in the future. Spatial clarity is also mentioned in the Law No. 41 of 2009 on the Protection of Agricultural Land Husbandry, but not yet integrated in the whole district and its RPJMN RPJP. Other regulations are the Government Regulation No. 1 of 2011 on the Determination of Transfer Function and Sustainable Agricultural Land and the implementation of the regulations are still not optimal because they are still based on a comprehensive assessment of the various aspects related to the needs and resources to support their territory. The rules regarding incentives also exist, namely Government Regulation No. 12 of 2012 on Agricultural Land Protection Sustainable Incentives, implementation of this regulation are still not optimal because of the high land owner farmers converting paddy fields farmers' fields. In other words, their basic needs were not accommodated. An overview of the constructing factors on the legal and institutional dimensions are shown in Figure 9.

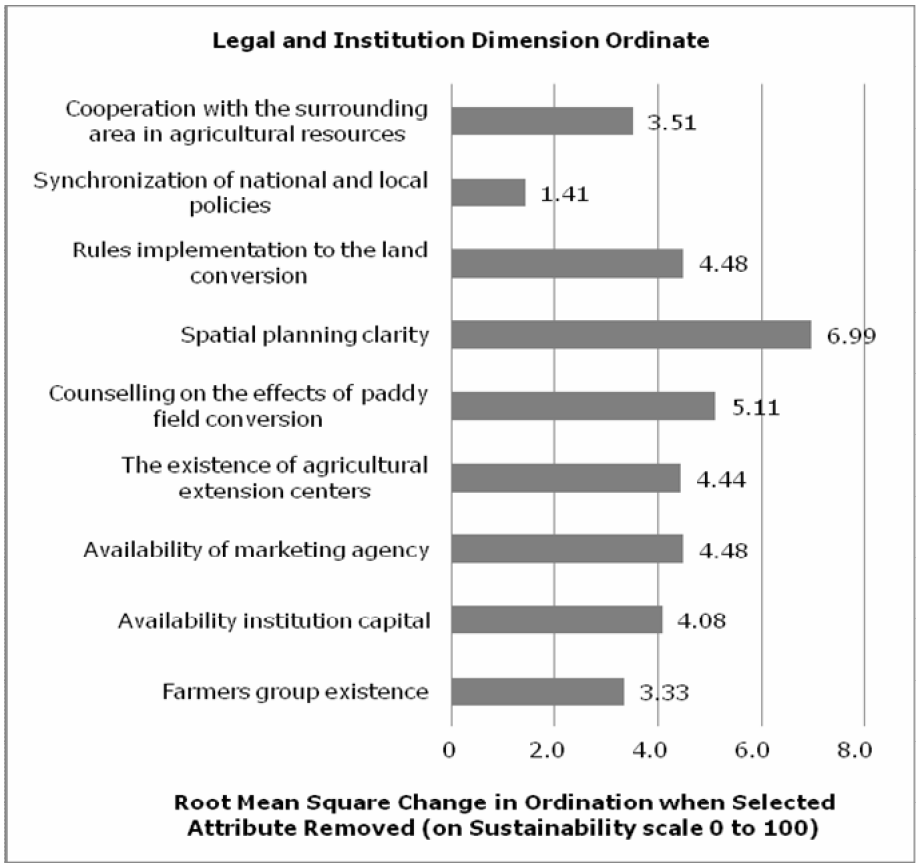

Figure 9. Factors on legal and institutional dimensions.

The sustainability status conditions for the legal and institutional dimension have the most good status of all dimensions with a value of 67.88 included in the sustainability criteria. This is because the regulatory and institutional support both in its implementation is not optimal, but the availability of the device is a key factor in minimizing the rate of wetland conversion. Ordinated picture of the status of sustainability in the legal and institutional dimensions is shown in Figure 10.

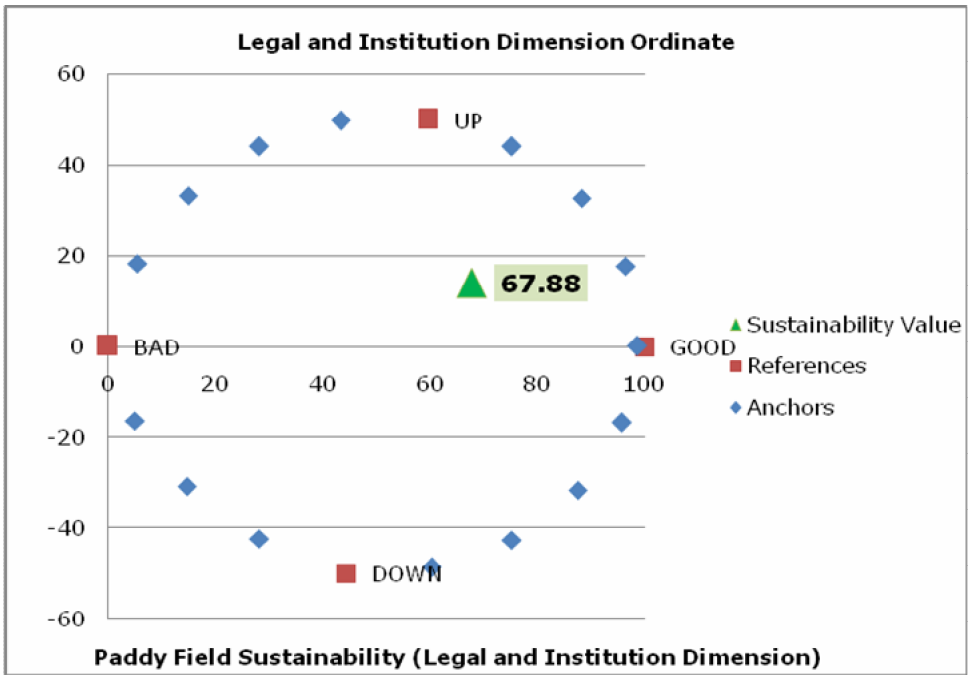

Figure 10. Status sustainability legal and institutional dimensions.

Multi dimensional scalling and validity analysis. Results of analysis using the MDS generates an index value of sustainability functions of wetland resources in the four counties as a center of rice production in Citarum. Where the value of the highest sustainability in the legal and institutional dimensions is 67.88 and the lowest in infrastructure and technology dimensions is 45.93. Inter-dimensional visualization of the status of sustainability are as shown in Figure 11.

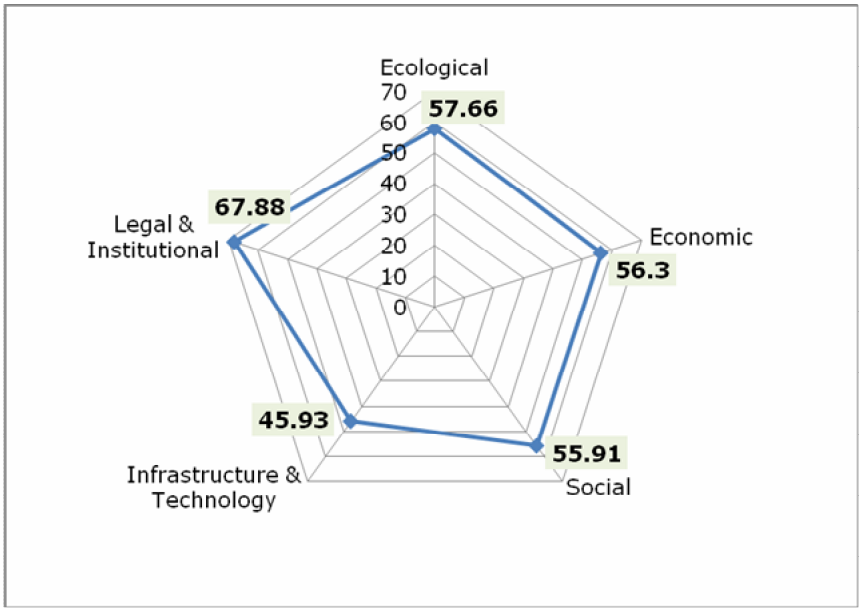

Figure 11. Multi-dimensional sustainability status.

The validity of the MDS used Montecarlo analysis, whereby the difference of the results of the comparative analysis of MDS montecarlo values is shown in Table 2.

Table 2

The result of Monte Carlo Analysis for Multidimensional Sustainable Index Values and each Dimension in the confidence interval of 95%

Index Status	*MDS*	*Montecarlo*	*Difference*
Social	55.91	55.34	0.57
Economy	56.30	55.49	0.81
Ecology	57.66	57.13	0.53
Infrastructure & Technology	45.93	45.87	0.06
Law & Institution	67.88	66.36	1.52

In Table 2, the results of the analysis with MDS and the method of analysis with the Monte Carlo method produce such a difference in column 4, and the value of the difference is very small, not more than 5%. This proves that the level of confidence in the total index (Multidimensional) and confidence in the value of the index of every dimension, and the effect of errors can affect the whole process of analysis by the method of MDS, and it is to exceed 95%. Therefore, from the analysis with the Monte Carlo method produced that 1). the effect of errors on scores for each attributes is very small; 2). errors that are the result of the understanding, the difference in opinion, or judgment of a researcher who has different opinion from each other are relatively very small; 3). data entry errors or missing data, or the value of "stress" that are too high are very small; 4). procedure errors that can affect the stability of the MDS analysis process is also relatively small.

Maintaining policy directives in the existence of wetlands. Policy in the control of wetland conversion that is particular in maintaining the presence of wetland rice

production centers in Citarum halted from upper-middle-end based on the design policy of the analysis of MDS is to consider constructing factors of agricultural extension, the amount of labor of farmers, the pressure to other uses, saprodi conditions of agriculture and spatial clarity.

Agricultural extension. Policies that can be done is:

- increase in agricultural extension through door to door in the farmers' groups and the provision of training for extension workers to better understand and to be more communicative;
- planning the activities of its role as an agricultural extension and farmer assistants at regular intervals;
- collaboration with experts and practitioners who come from universities and other institutions that are competent in related fields, provide knowledge and training on intensification, techniques and technology of agriculture and agribusiness to society, especially farmers by extension workers and NGOs on a regular basis and socialization of love of agriculture by extension workers and NGOs periodically evaluate the activities carried out by agricultural extension workers on a regular basis, and monitor the implementation of ongoing activities.

The number of farmer labor

- disseminating information and an overview that employment in the agricultural sector is better than the factory worker who are only momentary and can be dismissed at any time;
- development with the adoption of intercropping, such as land use for soybeans if the time span between harvest level of soy consumption is quite high and has increased continuously to a variety of foodstuffs, as in the case study in Karawang results research (Widiatmaka et al 2014), where soybean production in Karawang continue to fall from around 600 tonnes per year in 2013 to 400 tonnes per year in 2030, whereas the level of consumption of soy in the Karawang regency has increased due to increasing population, in which the needs in 2013 were more than 140,000 tons per year and increased continuously until 2030 where it will reach approximately 170,000 tons per year;
- development of agricultural waste utilization is as the application of blue economy (*how to make money from a waste*), where the use of rice husk can be developed into several derivatives business;
- in the increasing interest of successor farmers that needs to ensure the application of agricultural employment so that the children of farmers are interested in developing business in the agricultural sector, as well as the need for vocational special agriculture which provide free education for the children of farmers were directed to be ready to work in the agricultural sector, with the development of the concept of "Modern Farmer".

The pressure of land use

- setting restrictions on the use of land for residential development, services and industries such as the building manufacture with a particular preferred area to build vertically;
- dissemination and implementation of the setting rules and limits of the use of land for residential development and services, which includes support to food security and suitability land and monitoring the implementation of spatial development;
- industrial activities directed at environmentally friendly industries and contributed to a high area and required for the implementation of green production.

Conditions of agricultural inputs

- incentives in the form of farm inputs based on the results generated so that the rewards for farmers to improve good governance can increase an average per hectare of the farmers' good governance;
- help directed to begin the management of organic rice, due to better results and environmental friendly.

Spatial clarity

- zoning maker of rice fields is forbidden to be converted again. Assessment is adapted to the spatial and land suitability assessment of the various stakeholders, especially potential supporters of natural resources such as water availability and land conditions;

- increased water use efficiency through rice cultivation method system of rice intensification (SRI). In addition to applying the SRI method of organic agricultural land that are degraded can return as improved so as to provide optimum carrying capacity for increased production, which in turn targets national food security that can be achieved optimally (BBWSC 2011);

- making the determination of the rules and regulations contain provisions that support the land area of food security and restrictions on land use for the benefit beyond the use of agricultural land. The difficulty will be in the future wetland that currently needs to optimally utilize the paddy field and defend;

- emphasized the importance of land management in accordance with the site-specific nature of the limiting factors.In the research by Widiatmaka et al (2013) where the economic land suitability analysis results in Karawang show that both on the land class of S2 and S3 classes, cultivation of rice is still favorable, indicated by the values of gross margin and the ratio of B/C (Benefit Cost Ratio). However, calculations show that profits can be higher if the land can be increased in accordance with the potential land suitability, from S3 to S2 and from S2 to S1;

- rice fields should not be converted again and have a high potential that should be owned by the government, in order to minimize the vulnerability of land conversion to be managed by farmers, where farmers still have jobs as farmers.

Conclusions. Factors that influence the sustainability of the wetland in Citarum as the center of rice production is the optimization of agricultural extension services, the availability of the number of farm labor, especially in the future, the high pressure of land use, not optimal conditions of agriculture production facilities associated with the utilization of appropriate technology, as well as spatial clarity of wetland that does not consider the potential of its natural resources.

Of the various dimensions of sustainable conditions that are less obtained in infrastructure and technology dimensions with a value of 45.93, there is still not an optimal utilization of appropriate technology and irrigation infrastructure degradation under pressure because it is covered by industrial activity.

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