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# Economic Valuation of Rice Irrigated Area as the Flood Mitigation

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## ABSTRACT

Economic valuation of rice irrigated area as the flood mitigation was carried out in Sidoarjo Regency, East Java Province of Indonesia. Rice irrigated area which was still valuated as the food producer or plantation media during the time, in reality it could be functioned as small dams for storing rainfall for certain time. The function of irrigated rice area as the small dams was ad water support power which was able to hold, absorb, and store rainfall. Irrigated rice area as the flood mitigation was as non marketable goods. which was then in this study there would be carried out economic valuation. This study intended to investigate how much economic valuation of irrigated rice area as the flood mitigation that was as non marketable goods. The methodology consisted of Replacement Cost Method (RCM) for evaluating on environmental service of irrigated rice area. Results showed that there was very high function of rice irrigated area for storing rainfall while before flowing to downstream. Therefore, if there was happened the conversion of irrigated to non irrigated rice area would cause the lossing on flood mitigation of rice irrigated area that was proportional with 1,017 $m^3$ water per-hectar. The economic valuation of rice irrigated area on storing rainfall as the flood mitigation in location of studmillyards per-year was as Rp. 45,560,583.00 or Rp. 4,179,870.00 millions/ha. Based on the concersion of rice irrigated area in location of study during the last 10 years such as 300 hectars/year, the lossing valuation of rice irrigated area as the flood mitigation was Rp. 1.25 millyards/year. Extremely, if the whole irrigated rice area were functioned change into non irrigated one, the economical loss was as Rp. 92.87 millyards
**Keywords**: valuation, economy, irrigated rice area, floods

## INTRODUCTION

Rice irrigated area can be functioned as flood mitigation. The function of rice irrigated area as the flood mitigation is as the ability of rice irrigated area for holding rainfall while the time during and a moment after rainfall. The ability of rice irrigated area for holding, absorbing, and storing rainfall is as the water support power. Volume of rainfall that becomes as run-off is determined by run-off coefficient such as the percentage of rainfall which becomes as surface water flow. Coefficient of surface flow is very influenced by some factors such as type of soil, slide slope, rainfall, intensity of rainfall, and type of vegetation. Generally, coefficient of surface water flow on forest area is smaller than the area of residence, insudtry, street, bridge, office, etc [1].

According to Irawan [2], the coefficient of surface run-off on some of land coverings indicated that developed area (residence, insudtry, street, bridge, office, etc.) will produce surface run-off of 50 – 90 % from rainfall and it is depended on the area density. Coefficient of surface run-off in crowded center of city is about 70 – 95 % and in the village is 50 – 70 %, in the street is 70 – 95 % and it is depended on the quality of street. On the contrary, coefficient of surface run-off in unopened area like shrub and garden, irrigated rice area are relatively small such as approximate to 10 -30 %. Coefficient value of surface flow water will be very related with rainfall and rainfall day. In evaluating irrigated rice area economically can be carried out by approching the economic valuation of irrigated rice area as the producer and income source of farmer, the function of work supplier, the function of food deffence stability, flood mitigation, natural nutrision supplier, air pollution control, groundwater supplier, erosion and sedimentation control, sliding control, absorber of organic waste, absorber of $CO_2$, producer of $O_2$, variety of biology, habitat conservation, seldom species, etc. However, in this study, the economic valuation of rice irrigated area was only seen from the aspect of flood mitigation function.

The objective of this study was to investigate how much the economic valuation of irrigated rice area as the function of flood mitigation which was as non marjetable goods. Results could be used as follow: 1) the economic valuation of irrigated rice area function as the flood mitigation could be used as the consideration in

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conversing irrigated rice area; 2) the learning material for widely society which during the time irrigated rice area was only assumed as plantation media; 3) data source for the next researcher in the same field for knowledge science and technology development. In addition, the novely of this study was the giving of economic valuation for environmental services on irrihgated rice area as the flood mitigation which was as non marketable goods before. Theory of economy can describe the phenomenon on cnversion of irrigated to non irrigated rice area through the ration analysis of area rent [3].

## MATERIALS AND METHODS

This research was conducted in Sidoarjo Regency, East Java Province of Indonesia. The selection of research location was based on the considerations as follow: a) conversion of irrigated rice area in this location was relatively high as the impact of city regional development (Sidiarjo Regency was as the support of Surabaya city) mainly for residence or industry; and b) during the last ten years, frequency of floods were relatively happened and felt on the population at surrounded it.

Collected data included primary and secondary data. Secondary data consisted of soil map, land use, rainfall, rainfall day, flood event and disaster, and regional space planning. Secondary data were collected from many documents and publication of related instantion such as soil map and land use. In addition, most of regional data were obtained from village potency data dus to the result of the newest sensus. Primary data were directly collected from field through the interview with respondents about cause of flood, alternative of flood mitigation, depth of raired path, depth of water inundation before and after rainfall.

Sidoarjo Regency consists of 18 districts. From the 18 districts, there was selected 2 districts as the research locations such as Jiken Village of Tulangan District where represented farmers and Sidokare Village of Sidoarjo District where represented the society which were often attacking flood. Determination of location was purposively selected due to the consideration that Jiken Village was as the one village in Sidoarjo Regency that still reflected agricultural village, but Sidokare Village was as one of the village that was often attacking flood in the last ten years. Respondents of farmers were selected about 10 % from the total of farmers such as 30 of 299 farmers in this village, but the society respondents of non farmers which were often attacking flood were selected fro 30 persons of the whole population. Determination of respondents for survey activity used aimple random and purposive sampling method. Replacement Cost Method (RCM) was used on evaluation of economy in irrigated rice area as the flood mitigation. The formula of economic valuation of irrigated rice area as the function of flood mitigation (NEPB) [4].

$$NEPB = (D_p) \times A \times (P_d + O_d)$$

Note:

Dp = water support power of roce irrigated area ($m^3$)
A = area number of rice irrigated area (ha)
Pd = depresiation cost of DAM ($Rp/m^3$)
Od = maintenance cost of DAM ($Rp/m^3$)

## RESULTS AND DISCUSSION

Part of rainfall will be falling into sea and the other part will be falling in the land. Rainfall which is falling in the land, part of them is falling in agricultural area, the other part wis falling in opened area and developed area. Rainfall which is falling in agricultural area will be hold by canopyor crop hair ornament (leaf, branch, and tree), stagnant in soil surface, and or it is absorbed by soil through sil pores so that only a little part of the rainfall will become as run-off. Rainfall which falls in forest giving an easy illustration to be understood [5]. Research of Asdak [6] indicated that natural forest had the power of rainfall interception and stem flow each of 11.4 % and 1.4 %, and the rest of 87.2 % will be absorbed by soil surface. Second crop which has the different rainfall interception power is depended on the type and phase of growth. Corn and soja-bean has rainfall interception power of 3.9 % on the slow growing phase and 15-16 % on the fast growing phase.

If rainfall falls in developed area like residence, industry area, street, and bridge, so part of them will immediately become as run off.because there was no holder. However, rainfall that falls in agricultural area mainly irrigated rice area, most of them will be hold, absorbed, and inundated. The ability of agricultural area mainly irrigated rice area for holding, absorbing, and storing rainfall is named as water support [7]. Volume of rainfall that becomes as run-off is determined by run-off coefficient such as the percentage of rainfall which becomes as run-off. Run-off coefficient is influenced by many factors like soil type, slid slope, rainfall intensity of rainfall, and type of vegetation. Generally, run-off coefficient of forest area is smaller that agricultural area, and in agricultural area is smaller than developed area (residence, industry area, or iffice and service, etc.)

Irrigated rice area can be functioned as natural pools such as small dams which is able to store or hold rainfall before flowing to downstream through water bodies like river, irrigation channel, etc. Irrigated rice area as the flood mitigation has ability to hold rainfall while during and a moment after rainfall and it will be more functioned as flood mitigation in the areas where the intensity rainfall is so high because it is able to hold surface run-off that will cause flood [8].

The ability of irrigated rice area for supporting or storing rainfall in a short time after rainfall can be influenced by available irrigated rice area, the different of rarired path depth with water inundation depth before rainfall. The area surface number of paddy leaf is relatively small and water content of groundwater in steady condition, so hair ornament of rice and soil absorbed power in irrigated rice area is very small on holding rainfall. Area number and the depth of rared path on irrigated rice area is as the main factor which determines the ability of irrigated rice area to hold water [9].

The depth of rared path on irrigated rice area in research location is in the range of 20-35 xm with the average of 24.67 cm, but the depth pf water inundation in irrigated rice area before rainfall is inthe range of 10-15 cm with the average of 12.50 cm. Therefore, water support power on irrigated rice area is in the range of 5-20 cm with the average of 12.17 cm, so 1 hectare of irrigated rice area can support water of 12.17 x 10,000 $m^2$ or 1,217 $m^3$/ha.

Therefore, the depth of rared path is as one of the factors which can be manipulated for increasing the support power of rainfall in irrigated rice area. The higher rared-path of irrigated rice area will cause the higher rainfall support power and on the contrary.

In the location of research, because of the farmers have more effort in irrigated rice area farming, so the depth of rared path does not become as a problem. It is different with the farmers that usually plants fishes will think more important the higher rared-path.

Seeing how big the function of irrigated rice area in storing rainfall for a short time before flowing to downstream, so if there is happened the conversion from irrigated to non irrigated rice area (residence, industry area, recreation, etc) will cause the lossing of ability on flood mitigation of irrigated rice area which is proportional with the quantity of water which is stored on the depth of 10.17 cm (12.17 cm – 2.0 cm) or 1,017 $m^3$/ha (10.17 cm x 10,000 $m^2$). The value of 2.0 cm is as the water support power in the developed area. Figure 1 presented water support power in irrigated rice and developed area.

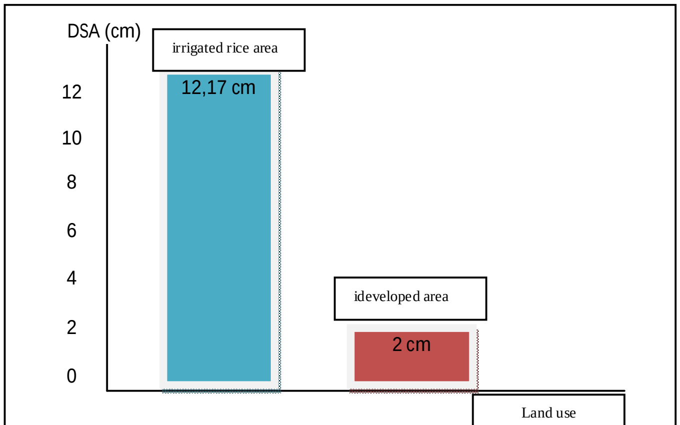


Figure 1 Water support power in irrigated rice and developed area

If based on the conversion of irrigated rice area in Sidoarjo Regency such as in average of 300 ha per-year, but area number of irrigated rice area in Sidoarjo Regency was 22,219 ha. Extremely if the whole area number of irrigated rice area (22,219 ha) in Sidoarjo Regency was functioned change into non irrigated rice area, while the other condition did not change (ceteris paribus), so there cpuld be analyzed the water volume that could not be stored by irrigated rice area in Sidoarjo was 22,596.723 $m^3$ (22,219 ha x 1.017 $m^3$/ha).

The average of rainfall in research location reached 1,794.64 mm/year with the aerage of rainfall day was 104 days/year, so the average of surface run-off total reached 186,642.56 $m^3$/year or 511.35 $m^3$/day. Therefore, the potency of surface run-off in Sidoarjo Regency with area number of 22,219 ha would reach 11.36 millions $m^3$. If there was compared with reservoir development, so the nearest reservoir from Sidoarjo Regency was Nipa reservoir. The water volume of surface run-off was far higher than the capacity of Nipa reservoir in Sampang Regency with the capacity of 7.5 millions $m^3$.

As described as above that irrigated rice area was functioned as small dams in storing rainfall in a short time before flowing to downstream, so theoritically, the function of flood mitigation on irrigated rice area could be changed by building reservoir or dam or reservoir which could store surface run-off which could not be stored by irrigated rice area. Based on the understanding, so there was used the development planning illustration of Nipa reservoir, Sampang Regency in 2011 as the prototype for storing surface run-off whereas the conversion of irrigated into nin irrigated rice area was continued. Nipa reservoir in Sampang Regency with the capacity of 7.5 millions $m^3$, the average of depresiation cost on Nipa reservoir was Rp. 3,360 $m^3$/year and maintenance cost was Rp. 750.-/$m^3$/year and based on the formula as follow:

$$\mathbf{NEPB = (D_p \times A \times (P_d + Q_d)}$$

Note:

NEPB = economic valuation of irrigated rice area as the function of flood mitigation
Dp = water support power on irrigated rice area ($m^3$)
A = area number of irrigated rice area (ha)
Pd = depresiation cost of reservoir (Rp/$m^3$)
Qd = maintenance cost of reservoir (Rp/$m^3$)

NEPB = 1.017 $m^3$/ha x 10,9 ha x (Rp 3.360/$m^3$ + Rp 750 $m^3$)
= 1.017 $m^3$/ha x 10,9 ha x ( Rp 4.110/$m^3$)
= Rp. 45.560.583
= **Rp**. 4.179.870 juta/ha

Economic valuation of irrigated rice area as the function of flood mitigation in research area was as Rp. 45,560,583.00 or Rp. 4,179,870.00 millions/ha. If based on the conversion of irrigated rice area in research location during the last ten years such as 300 hectares/year, so the loss benefit from irrigated rice area valuationas the flood mitigation was as Rp. 1.25 millyards/year. Extremely, if the whole irrigated rice area was functioned change into non irrigated one, so the economic loss was as Rp. 92.87 millyards.

If the conversion of irrigated rice area in research location was continued with the same proportion, so the loss potency on the water wupport power of irrigated rice area was bigger and it would cause on the higher cost of needed flood mitigation. The value of flood mitigation based on the concept of water support power was only as the approach due to the consideration that the rainfall was not more than water support power of irrigated rice area. However, if the rainfall was more than water support power of irrigated rice area, the water volume of surface run-off would be more bigger and flood mitigation cost was also increasing. Rainfall data suring the last ten years in research location indicated that intensity of rainfall from year to year was so much decreasing.

Nowadays, if the multi-function of irrigated rice area in the world was known for about 30 [10], so the averaged function of one irrigated rice area was Rp. 4,179,870.00 millions/ha, so the economic valuation of irrigated rive area was Rp. 125.4 millions/ha. This value actually gave the consideration in decision making for coversing the iirigated into non irrigated rice area.

## CONCLUSION

Based on the research of economic valuation of irrigated rice area as the food mitigation, it was concluded as follow:

1. Irrigated rice area can be functioned as the natural pools as small dams which are able to store or hold rainfall before flowing to downstream through the water bodies like river, irrigation channel, etc.
2. The depth of rared path in research location was in the average of 24.67 vm, but the depth of water inundation in irrigated rice area before rainfall was in the average of 12.50 cm. Therefore, the water support power in irrigated rice area was in the average of 12,17 cm so that in irrigated rice area of 1 ha could support rainfall of 12.17 cm x 10,000 $m^2$ or 1.217 $m^3$/ha. Therefore, the depth of rared path was as one of the factors that was manipulated for increasing the rainfall support power in irrigated rice area, the higher rared path depth of irrigated rice area would cause the bigger rainfall support power and on the contrary.
3. The function of irrigated rice area in storing rainfall in a short time before flowing to downstream was big enough, so if there was the conversion of irrigated into non irrigated rice area (residence, industry, etc) would cause the losses of irrigated rice area ability as the flood mitigation which was proportional with the stored water of 1.017 $m^3$/ha.
4. Economic valuation of irrigated rice area as the flood mitigation in research location was Rp. 45,560,583.00 or Rp. 4,179.80 millions/ha. If based on the conversion of irrigated rice area in research location during the last 10 years was 300 ha/year so the benefit or the losses valuation of irrigated rice area ability as the flood mitigation was minimal of Rp. 1.25 millyards/year.

## SUGGESTION

1. This research discuss about the multi-function of irrigated rice area from positive aspect such as the function as flood mitigation, but the negative aspect has not been carried out in this research, so it is hoped the next research can analyze the multi function of irrigated rice area in negatice aspect.
2. Remembering that the multi function of irrigated rice area biophysically is much enough, so it is hoped the research about multi function of irrigated rice area is nacessary to be developed from multi function aspect as well as the aspect of analysis method and location scale.
3. There is hoped that results of the research on irrigated rice area multi function can be as the planning or policy in conversing irrigated into non irrigated rice area.

## REFERENCES


1. Yoshida K. 2001. An Economic Evaluation of the Multifungtional Roles and Agriculture and Rural Areas in Japan. *Technical Bulletin* 154. August 2001. FFTC. Taipeh.
2. Irawan B. 2005. Konversi Lahan Sawah: Potensi dampak, pola pemanfaatannyadan faktor determinan. *Forum Agro Ekonomi* 23(1): 1-18 Pusat Penelitian dan Pengembangan Sosial Ekonomi Pertanian. Bogor.
3. Nasoetion LI. 2003. Konversi Lahan Pertanian : Aspek Hukum dan Implementasinya. Di dalam U. Kurnia, F. Agus, D. Setyorini dan A. Setyanto (Penyunting). *Prosiding Seminar Nasional Multifungsi dan Konversi Lahan Pertanian. Pusat Penelitian dan Pengembangan Tanah dan Agroklimat*, Bogor.
4. Eom KC & Seong-HO Y. 2004. Public benefit from Paddy Soil. *The Journal of Korea Society of Soil science and Fertilizer*. 26 (4) : 314-333
5. Agus, F. dan E. Husen 2005. Tinjauan Umum Multifungsi Pertanian. *Seminar Nasional Multifungsi Pertanian dan Ketahanan Pangan. Balai Penelitian Tanah*. Badan Litbang Pertanian. Bogor
6. Asdak, C. 2002. *Hidrologi dan Pengelolaan Daerah Aliran Sungai.* Gadjah Mada University Press. Yogjakarta. 571 hal.
7. Irawan. B 2007. *Valuasi Ekonomi Lahan Pertanian, Pendekatan Nilai Manfaat Multifungsi Lahan Sawah dan Lahan Kering* (Studi Kasus di Sub DAS Citarik Kabupaten Bandung Jawa Barat.
8. Suparmoko M dan Suparmoko MR. 2000. Ekonomika Lingkungan (Edisi Pertama), BPPE. Yogjakarta.. Implication For Economic Valuation. *Jounal of Enviromental Management*.
9. Eom KC & Seong-HO Y. 2004. Public benefit from Paddy Soil. *The Journal of Korea Society of Soil science and Fertilizer.* 26 (4) : 314-333
10. Suh DK. 2001. Social and Economic Valuation of the Multifungtionality Roles of Paddy Farming. *International Seminar on Multi-functionality of Agriculture*, 17-19 October 2001. JIRCAS., Tsukuba, Ibaraki, Japan.