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An Institutional Model of Transboundary Watershed Management Toward Sustainable Development

Werenfridus Taena[1*], Lala Mulyowibowo Kolopaking[2], Bambang Juanda[3], Baba Barus[4], Rizaldi Boer[5]

[1]Faculty of Agriculture, Timor University, Kefamenanu, East Nusa Tenggara, Indonesia 85613
[2]Research Center for Agricultural and Villages Development, Bogor Agricultural University, Campus IPB Dramaga, Bogor, Indonesia 16680
[3]Regional and Rural Development Planning Study Program, Bogor Agricultural University, Campus IPB Dramaga, Bogor, Indonesia 16680
[4]Department of Soil Science, Bogor Agricultural University, Campus IPB Dramaga, Bogor, Indonesia 16680
[5]Center for Climate Change Risk and Opportunity Management Southeast Asia and Pacific, Bogor Agricultural University, Campus IPB Dramaga, Bogor, Indonesia 16680

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Abstract

The objective of this study were to evaluate the institutional of watershed management in border area of Indonesia and Timor-Leste, and to design a model of transboundary watershed management institution for Indonesia and Timor-Leste. Weighting of internal and external factors method was used to evaluate the institutional transboundary watershed management, while analytical hierarchy process was used to compute the institutional model of transboundary watershed management. The internal factors consists of: the commitment of the stakeholder in watershed management, development priorities at border area, the limited institutional cooperation, the land use changes. The external factors are: international environmental agenda on development country, international conferences that supported the countries collaboration toward sustainable development achievement, supporting culture in forest and water resources protection, slash and burn cultivation activities, conflicts, lack of ecological. The result showed that weighting of internal and external factors on quadrant III is alternaltive institutional model of transboundary watershed management. The priority alternatives institutional model and also road map for sustainable development are collaboration agreement of transboundary management, transboundary watershed forum, and autonomous transboundary watershed management. The alternatives institutional has relation with the development phase, condition of local community and environment.

Keywords: institutional, transboundary, watershed management, Indonesia and Timor-Leste, sustainable development

**Correspondence author, email: weren_ntt@yahoo.co.id, ph: +62-8137475611*

Introduction

Management of natural resources tend to be exploitative, thereby reducing the capacity of the environment and lead to negative externalities such as floods and droughts. Fauzi (2010) stated that externality were the development activities with adverse impact to other party. A decrease in the carrying capacity of the environment and negative externalities can be managed into sustainable management. Earth Rio Summit Conference 2012 recommends resource management to aim sustainable development through green economic, the institutional framework for sustainable development, collective action (UN 2012). When the source and recipient of externalities in different countries, it is necessary to transboundary management (Wondwosen 2008).Watershed is an area/region/zone of a hydrological unit that formed naturally through water catchment (from rain) and flows across the area to tributaries and river (Kodoatie & Sjarief 2010). As a hydrological unit, the externalities of resources management in a watershed could be traced, therefore the sources and recipients of externalities could be determined. Resources in a watershed, natural, and artificial resources are mandated to be developed and utilized optimally and sustainability through the efforts of watershed management (PP RI No. 37/2012). Resources in a watershed are managed by or under different authority or sector agencies, even under different countries such as 10 watersheds which cover regions between Indonesia and Timor-Leste. One of them is Tono Watershed, which is important role for Indonesia and Timor-Leste people's livelihood, but flood and drought occur frequently, due to mis-management resources in areas of both countries.

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The watershed management requires an integrated management approach covering the upstream, midstream, and downstream in terms of function and administration. The fact in Indonesia and Timor-Leste are the countries determined by the state boundaries based on administrative border without observing the watershed boundary (ecologychal approach). This has triggered externality. Therefore, it needs to watershed management and land use management which is a part of the institutional designed to overcome externality in neighboring countries and to achieve the sustainable development Yu *et al.* (2004). Some watersheds in the world that has been managed jointly by the cross countries, e.g. the Mekong Watershed (authority), the Senegal Watershed (agreement), the Danube Watershed (commission), as stated by Kartodihardjo *et al.* (2004). This study aimed to (i) evaluate the institutional of state-border watershed management, and (ii) design a model of transboundary watershed management institution for Indonesia and Timor-Leste.

Methods

Location of this study on Tono Watershed, Borderland, Indonesia and Timor-Leste. Tono Watershed covers an area of 53.45 km^2, which is administratively, around 72.57% located in Timor-Leste (District Oecussi) and 27.43% in Indonesia (North Centre Timor District, East Nusa Tenggara Province). Oecussi designated as a special area because it is an enclave in the territory of Indonesia (Konstituisaun Republika Demokratika Timor-Leste 2000). The map of Tono Watershed based on zones is depicted in Figure 1. The study was conducted over the period of April to Oktober 2014 in Indonesia and Timor-Leste.

Data used in this study are primary and secondary data. Primary data collected through depth interview. The interviews were conducted amongs stakeholders both from Indonesia and Timor-Leste. Total number of stakeholders are 30 respondents, 15 respondents from Indonesia and 15 respondents from Timor-Leste. The stakeholders were representative of the governments, communities and experts. The secondary data consist of monthly rainfall data (http://chg-ftpout.geog.ucsb.edu/puborg/chg/products/CHIRPS-2.0/global-monthly/tifs/), monthly temperature (http://iridl.ldeo.columbia.edu/SOURCES/.UEA/.CRU/.TS3p0/), and land use (landsat). Other secondary data such as total area and institution were obtained from institutions in both of Indonesia and Timor-Leste.

Analysis The analyzed data used weighting SWOT (strength, weakness, opportunity, threat) to evaluated the internal and external factors of transboundary watershed management institution (Rangkuti 2006). The results of weighting are used to determine the institutional development strategy. The designed of the institutional model of transboundary watershed management used analytical hierarchy process (AHP) approach based on formula by Saaty (1993). The AHP procedures are as follows:

1 Identification of problem (internal and external factor analysis), and expected solution (used institutional development strategy),
2 Develop a hierarchical structure as displayed on Figure 2. Hierarchical structure consist of: the expected solution (transboundary watershed management) was used on sustainable development (as hierarchy 1). The principle of sustainable development becomes a factor analysis (as hierarchy 2), which is divided into several alternatives factor (as hierarchy 3). Actors or stakeholders to beneficial and play a role on tranboundary watershed management (as hierarchy 4). Then, each stakeholder

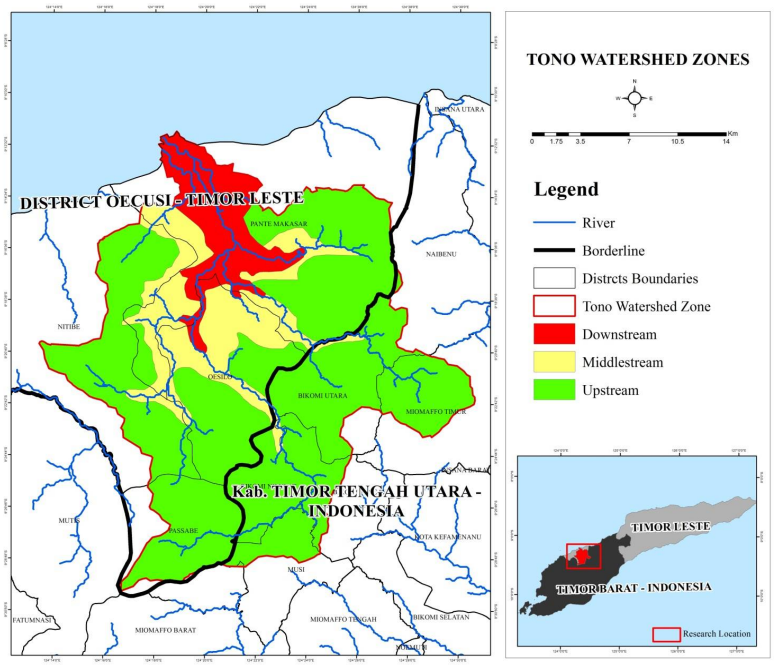

Figure 1 The zones of Tono watershed.

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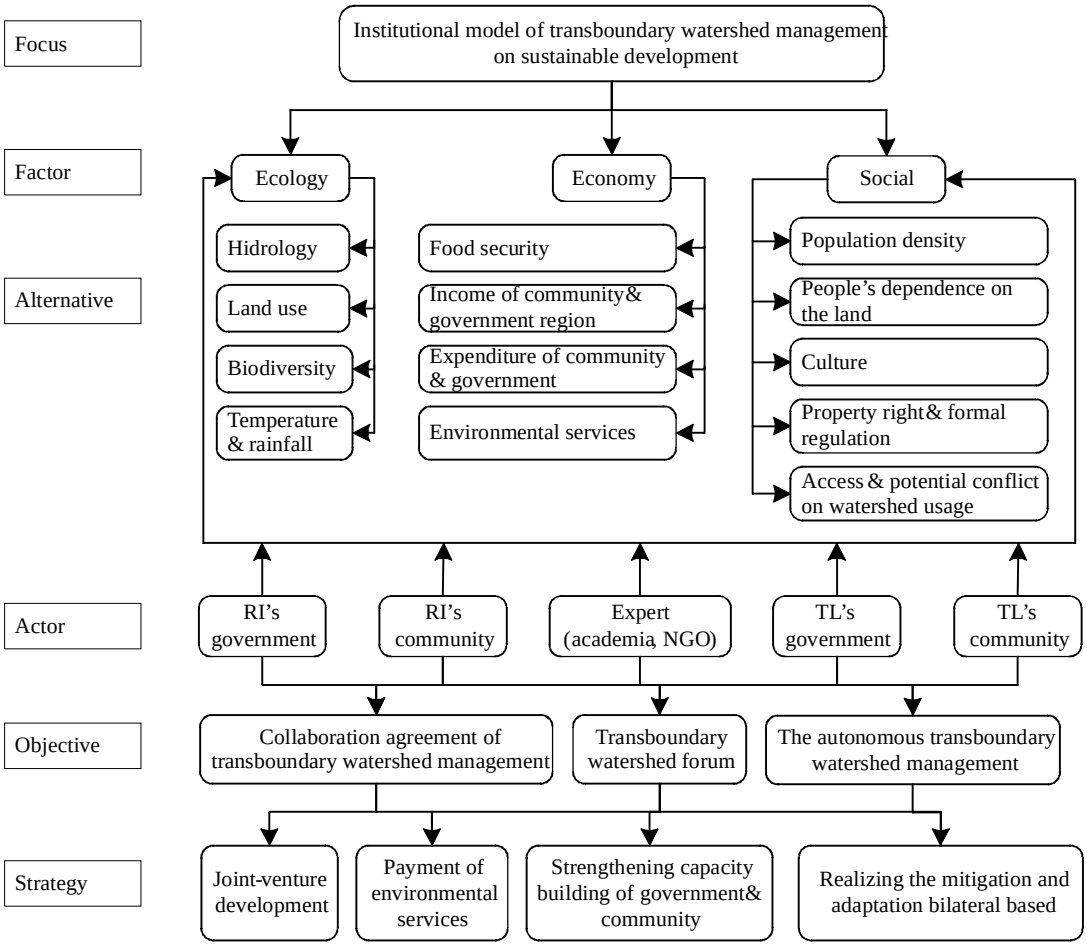

Figure 2 AHP structure of institutional of transboundary watershed management on sustainable development framework.

determine institutional solution (as hierarchy 5) and action (strategy) from each alternatif institutional to be the watershed management (as hierarchy 6) for sustainable development in the border region of the country.

3 Develop a matrix and pairwise comparison value as displayed on Table 1.

4 Set up a pairwise comparison and logical consistency using software *expert choice* 2000. Each analysis was complemented by a descriptive analysis.

Results and Discussion

Internal and external factors of institutional of transboundary watershed management The strengths of Tono Watershed management was collaboration commitment in transboundary watershed management signed by two countries, and priority development on the border area, that is functionally located in the watershed. Commitment joint watershed management has been done in 1972, to overcome the uneven distribution of water in Africa (Lautze & Guardano 2005). The weaknesses on transboundary management in Indonesia and Timor-Leste were the partial watershed management, subsistence farming (slash and burn) on Tono watershed, and land use changes from conservation area to cultivation area. Land use changes of Tono Watershed in 2000 and 2014 is presented in Table 2.

The opportunities used to overcome the weaknesses were development priority in development country in order to contribute the sustainable development, as Lautze and Guardano (2005) stated that international environmental agenda, international conventions and conferences supporting the collaboration between countries (bilateral and multilateral) towards sustainable development. Then, people precence in border area of Indonesia and Timor-Leste to protect the culture of forest and water resources, and strong kinship between the people who living in the border area. Therefore, interaction of social, culture, and economic are irrespective of national borders (Taena *et al.* 2013). However, there are some threats from variability of monthly rainfall and temperature, flood and drought, conflicts among regions in border area, development that is not aligned to environmental perspective. The scale of internal and external factors on Tono Watershed are presented in Table 3 and Table 4.

The partial watershed management to colaborative watershed management recomended follow weighting scale of internal and external factors, showed that the strength factors have score 1.18 and the weaknesses was 1.62. Total

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Table 1 Matrix of pairwise comparison

	A_1	A_2	A_3	...	A_n
A_1	W_1/W_1	W_1/W_2	W_1/W_3	...	W_1/W_n
A_2	W_2/W_1	W_2/W_2	W_2/W_3	...	W_2/W_n
A_3	W_3/W_1	W_3/W_2	W_3/W_3	...	W_3/W_n
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
A_n	W_n/W_1	W_n/W_2	W_n/W_3	...	W_n/W_n

Source: (Saaty 1993)

Table 2 Covered area of Tono Watershed land use based country (RI: Indonesia, TL: Timor Leste) in 2000 and 2014

Land use	2000		2014	
	RI	TL	RI	TL
Secondary dryland forest (ha)	617.21	86.23	588.84	86.23
Open area (ha)	63.81	980.65	55.03	1039.91
Settlement (ha)	109.33	152.79	336.54	213.68
Dryland agriculture (ha)	932.87	1,909.17	2.922,09	2,460.84
Mixed dryland agriculture (ha)	322.11	16,780.20	3.308,58	19,353.47
Savanna (ha)	235.27	6,999.36	346.06	6,021.97
Paddy fields (ha)	50.79	886.38	145.59	1,181.35
Shrubs (ha)	12,425.24	9,145.31	7,053.89	6,597.28
Swamp-shrubs (ha)	0.00	48.33	-	40.22
Water bodies (ha)	6.29	1,712.74	6.29	1,706.21
Total (ha)	14,762.91	38,701.16	14,762.91	38,701.16

score of the opportunity factors was 2.18 and the threat factors was 0.67. Difference score between strengths and weaknesses was -0.45, meanwhile score difference between opportunities and threats was 1.49 or in quadrant III cartesian diagram. Rangkuti (2006) stated that the cartesian diagram had 4 quadrants in the SWOT matrix, each quadrant representing one strategy. Quadrant I was the quadrant for positive internal and external factors; so that, the used strategy was progressive. Quadrant II was characterized by positive internal factors and negative external factors; meaning, diversification as the strategy. Quadrant III consists of negative internal factors and positive external factors; so that, changing was the main strategy. Finally, quadrant IV was formed by negative internal and external factors; which, the strategy applied was the defensive strategy. Details of each strategy is presented in Table 5.

Recommended strategy for quadrant III was improving the transboundary watershed management. The strategies to achieve the goals were (i) the government of Indonesia revised the regulations, and the government of Timor-Leste formulated the regulations of transboundary watershed management, (ii) the establishment of transboundary watershed management institutions toward sustainable development, (iii) integrated watershed management, (iv) reforestation and changes slash and burn farming into permanent farming, (v) increasing productivity of agriculture by applying suitable agricultural technology. The overarching strategy of the whole strategy (in Quadrant III) is an establishment of tranboundary watershed management to aim sustainable development on border area of Indonesia and Timor-Leste. Transboundary watershed management as referals from other countries, Wondwosen (2008) stated that collaboration among countries on the Nile watershed management aimed to (i) develope the Nile watershed resources through fairly and sustainability to ensure the welfare, safety, and peace of the inhabitants, (ii) ensure an effective water resource management and an optimum water resource utilization, (iii) improve the collaboration and collective actions among member states, (iv) reduce poverty and improve economic integration.

Designed a model of transboundary watershed management institution. Priority of the sustainable development factor (dimension) in transboundary watershed management There are 3 dimensions of sustainable development analyzed in this research i.e. ecological, economic, and social dimensions, as stated by WCED (1987). To designed an institutional model of transboundary watershed constructed by determining the main factor of 3 factor of sustainable development. The result showed that the best factor to designed an institutional model is social factor was 63.50%, followed by the ecological factor was 22.40%, and economic factor was 14.10% on Tono Watershed. Further, the social, economic, and ecological factors were classified into sub-factors. The results of AHP on each of sub factor are presented in Table 6.

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Table 3 The matrix of external factors

External factors	Weight	Score	Total
Opportunities			
International conventions enable collaboration between countries in managing transborder natural resources	0.14	2.77	0.39
The experience of a number of countries in conducting watershed management could be used as references	0.15	3.37	0.52
International environment agenda	0.13	3.00	0.38
The joint border committee between Indonesia and Timor-Leste has been formed	0.16	3.10	0.48
The priority of development in the border area of Indonesia and Timor Leste	0.14	2.97	0.41
Development country in order to contribute to sustainable development goals	0.14	2.67	0.36
Threats			
Phenomena la nina and el nino	0.04	2.90	0.11
Global warning	0.09	1.83	0.17
The frequency of climate changes are more frequent	0.10	3.50	0.35
Climate changes difficult to predict with traditional way	0.04	1.47	0.05
The mechanism for transboundary watershed management budgeting	0.05	1.97	0.10

Table 4 The matrix of internal factors

Internal factors	Weight	Score	Total
Strengths			
The joint border committee between Indonesia and Timor-Leste has been formed	0.15	3.03	0.45
There is a law that regulates development of border area, and watershed management	0.06	2.50	0.16
The people living in the border area between Indonesia and Timor-Leste have kinship and protection culture of forest and water	0.08	2.53	0.20
The establishment of permanent dry field farmer groups is supported by extensions and supervision	0.06	2.23	0.12
The stakeholders have a commitment to collaborate in transboundary watershed management	0.13	3.13	0.40
Weaknesses			
The definitions of border area and watershed in some cases are spatially dissimilar	0.12	3.53	0.43
State institutions which manage the transborder watershed have been stated in a law, but up to this moment there is no transboundary watershed management which is within the borderland development framework	0.08	1.90	0.15
There are not yet any agreements between the countries pertaining to transboundary watershed management in the sustainable development framework	0.14	3.63	0.49
There are not yet any physical studies of the transboundary watershed because the studies that have been conducted in the past were generally limited by country territory	0.04	1.87	0.07
The stakeholders generally believe that watershed management is limited by administrative territory	0.12	2.43	0.28
Watershed management has been partial, only related to water resources and irrigation and that the management is usually with a short term perspective	0.03	1.83	0.06
The land use changes from conservation to cultivation area	0.06	2.53	0.16
The low economic efficiency of agriculture in the Tono Watershed	0.06	2.70	0.16

The social factor Paimin *et al.* (2012) stated that socially, the watershed provides land for agriculture, housing, the community cultural development, property rights and access to natural resources. The first priority of the social factor according to AHP results was the Tono Watershed provided land to fulfill the needs of the local community. Land use data showed that the local community relies on the land of Tono Watershed for accomplishing their daily needs. Around 52.23% of land on Tono watershed was used for dryland agriculture and mixed-dryland agriculture, 2.38% of land was used for paddy field, and 11.98% were savanna for livestock grazing.

The second priority was settlement. It continues to increase, started 262.12 ha in 2000 to 550.22 ha in 2014. There is due to increasing the population and establishment the sub disctrict. Demand of settlement area urged the development of a city (urbanization) which could trigger floods. Prawiranegara (2014) stated that the floods in the Marikina-Philippines watershed caused by: rapid urbanization affected the forest coverage loss, illegal settlement in conservation areas, unsustainable land used in downstream area, administrative border conflict, and issues of land property right.

The third was culture shaped by the interaction of the

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Scientific Article
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Table 5 The matrix of Indonesia and Timor-Leste transboundary watershed management strategy

	Weaknesses (1.62)	Strengths (1.18)
Opportunities (2.18)	**Quadrant III:** (i) Development of border area in Indonesia is not only based administration, but also based on ecologychal functional ; (ii) The Government of Timor-Leste formulates reg ulations about watershed management and spatial management; (iii) Designed a model of transboundary watershed management institutions to achieve sustainable development; (iv) an integrated watershed management, (v) changes slash and burn farming into permanent farming, (vi) increasing the productivity applying suitable agricultural technology	**Quadrant I:** (i) Collaboration in developing border area, (ii) Strengthening tribal institutions in managing water and forest resources; (iii) empowering the capacity of the local people to develop the culture of permanent farming
Threats (0.67)	**Quadrant IV:** (i) Maintaining the sovereignty of each country, increasing defense and the security of the people living in the border area; (ii) Maintaining activities that strengthen the sense of kinship and friendliness between the countries, (iii) Maintaining border area development withouht sustainable development perspective and the agricultural activities that was currently in practice on Tono Watershed	**Quadrant II:** (i) The development of border area achievement through sustainable development framework, (ii) Depth-Assessment of the physical characteristics of the watershed; (iii) Collaboration between technical transboundary watershed management and border area development institutions

local community with land and other resources on the Tono Watershed. Koentjaraningrat (2009) defined culture as all the ideas, systems, actions, and creations produced by man-kind in community life as a result of a learning process. The cultures that developed were *banul/banut* (Indonesia) and *tarabandu* (Timor-Leste) to preserve the forests and the water resources. Water preservation culture also practiced at each tribe on the *oekanaf* (sacred water). The *oekanaf* also played a role as an actor binding for all members of the tribes who dispersed through out Indonesia andTimor-Leste because their ceremonies involved all members of the tribe without separation based state administratively and territorial boundaries, as stated by Oii and Richard (2010), declaring that social and cultural norms united everybody in every institution.

Local Wisdom and formal low distributes property right of land, was the fourth priority. Property rights according to formal low, and the mechanism has developed in the local communities on the Tono Watershed. The forest on the Tono Watershed covered 675 ha (1.26%) which belong to state property, whereas 98.74% of the Tono Watershed was private property (dryland agricultural, mixed dryland agricultural, paddy fields, and settlement), and common property (savanna, schrubs, and part of the farm). The property rights of the upperstream on Tono Watershed are dominated by individual and the common. Rustiadi *et al.* (2011) stated that in general, the property rights of natural resources were categorized into (i) state property, the ownership claim belongs to the government, (ii) private property, the ownership claim belongs to individuals, (iii) common property or communal property: a group of individuals have claim on the jointly-managed resources.

Implications, the state has limited authority to manage the Tono Watershed. Therefore, access was the fifth priority. The access (resource management) was unstable due to pursue the highly illegal use so that accelerate the resource decreased sharply. Sudarmalik *et al.* (2014) stated that the government in some cases has limeted control to forest that is manage by the industry and community. In line with Sudarmalik *et al.* (2014), previous Fauzi (2010) had stated that the combination between property rights and access causes various policy implications. The Differences of property rights types have an effect on access and highly potentiall conflict on its utilization. In general, there are four possible combinations of property rights and access: (a) the first type: property rights owned by the government or the community with limited access. This combination type enabled sustainable management of natural resources; (b) the second type: property rights possessed by individuals with limited access. The uniqueness of this type: the characteristic of the ownership right was clearly defined andreduce the over-exploitation used, (c) the third type: a combination between communal property rights and open access, effected to tragedy of the common. (d) The fourth type: the resources are individually-owned, but open-access.

The ecological factor The ecological factor consists of hydrology, land use, biodiversity, temperature and rainfall (UNDP 2004). The Tono Watershed was ecologically beneficial used because the watershed was a undivided ecosystem extending from upperstrem, to the midstream and finally to the downstream. This means activities in the upperstream influenced the middle and downstream of the watershed. The priority analysis of the ecological sub-factor using AHP showed that the highest priority in the ecological sub-factor was that the watershed provides water for households, agricultural and livestock needs. Water resources were rare resources in the border-area between Indonesia and Timor-Leste; therefore, water has higher priority than land use, biodiversity, temperature and rainfall. Land use in upperstream of watershed effected the availability of water in all gradient of Tono Watershed area. Total of 85 springs located on the Tono Watershed which dispersed through out the Indonesian and Timor-Leste territories.

The availability of water resources is determined by

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Table 6 The result of the weighting scale on each sub-factors on Tono Watershed management to sustainable development on border area

Factor description	Weight	Priority
Social		
Population density	0.358	2
The people's dependence on the land	0.380	1
The cultural development of the community	0.128	3
The development of formal regulations in the watershed management	0.082	4
Property rights, access, and conflict potential in the utilization of the watershed	0.051	5
Ecology		
Hydrology	0.429	1
Land use	0.394	2
Biodiversity	0.093	3
Temperature and rainfall	0.084	4
Economy		
Food security	0.504	1
Increasing the community and regional income	0.323	2
Community and government expenditure for the watershed maintenance	0.087	3
Environmental services payment	0.086	4

forest area. Therefore, the land use changes is set as the second priority of the ecological sub-factor. Land use changes from conservation area to cultivation area. As a result, the number of springs and water volume has decreased. The size of the forest has reduced from 703 ha (in 2000) to 675 ha (in 2014) due to the increased demand of land for settlement and agriculture, triggering the conversion of the village forests. The limitation of the forest area and water resources influencing the biodiversity loss was the third priority. Apples were one of the biodiversity lost on Tono Watershed. In the 1970s, apples cultivated near the upperstream area of the Tono Watershed (in Fatusene Village), but now its cultivation has extinct. Implications, it needs to conservation the resources of water and forest resource to be started in watershed in order to increase the land coverage and water supply, as stated by Keller *et al.* (1998).

Biodiversity diminished due to climate change (temperature and rainfall) was the fourth priority. The average monthly precipitation was 146 mm in 2000 and it dropped to 110 mm in 2014 (http://chg-ftpout.geog.ucsb.edu/puborg/chg/products/CHIRPS-2.0/global-monthly/tifs/), while the average monthly temperature was stable relatively; 25.8 ºC in 2000 and 25.6 ºC in 2014 (http://iridl.ldeo.columbia.edu/SOURCES/.UEA/.CRU/.TS3p0/). The effect was the occurrence of droughts in the dry season and floods in the rainy season, causing low efficiency of farming. Schernewski *et al*. (2010) stated that climate changes and the interaction with other factors increase the risk of floods, and as a result, biodiversity decreases (including fish in coastal areas); therefore, Germany and Poland collaborated in managing the watershed. Cosens (2010) stated that the resilience of ecological system on environment change through reduced the natural resource management fragmentation can increase the transboundary watershed sustainability. The governments of the USA and Canada signed a collaboration agreement in order to reduce the competition for water access and the negative effects on border-area watershed management.

The economic factor The Watershed management increased the food security, community income, and regional development (UNDP 2004) and the payment of environmental services (Rosa *et al.* 2004). The results of the priority analysis of the Tono Watershed economic sub-factors displayed the food security as first priority. Ecologically, the Tono Watershed provided land and water which act as social property. This property is used by the local people for agriculture for enhanching food security on Tono Watershed. Marketing some of the agricultural products to increasing income of the people and the region was the second priority. Increasing the productivity of dryland and wetland agricultural activities helped the improvement of economic transactions which lead to empowering the economy system of the Tono Watershed.

The trade of agriculture input and output required supporting facilities, i.e. the expenditure of government and community as the third priority. Supporting facilities also cover border markets, dams, irrigation, new paddy fields, and roads. Government expense also was used for rehabilitating damages caused by floods, for example building retaining walls and gabions. Expenditure for watershed maintenance was minimized by applying the development policies based environmental carrying capacity-oriented (Santoso *et al.* 2014).

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The fourth priority was the policy of the payment of environmental service. The payment of environmental service mechanism was a reward and punishment for stakeholders in each territories. Policy and development activities in the watershed need to avoid externalities to other areas. Although, the payment of environmental services also causes problems as stated by Wondwosen (2008) based on lesson learn of the Nile Watershed management. These problems were: (a) there was no agreement on the allocation of water received by each countries, (b) there were political problems among a few of the member countries, (c) suspicion and distrust of the development of water and forest resources around the upperstream of the watershed. In terms of conflicts, it is suggested to develop collaboration based on profit sharing not water sharing.

Priority of actors The factors and sub-factors were perceived differently by the stakeholders in each countries and performed as the basic principals for determining the priority for the institutional model and its implementation in Indonesia and Timor-Leste. Datta and Gosh (2015) assigned greater importance by user groups. Actors of Tono Watershed are (i) community (Indonesia and Timor-Leste), (ii) the government (Indonesia and Timor-Leste), and (iii) watershed expert. Priority of stakeholder using analytichal hierarchy process is presented in Table 7.

Socially, Tono Watershed population is mainly in Oecussi District of Timor-Leste. This region on Tono watershed about 47.47%, while North Centre Timor District (Indonesia) only about 10% on Tono Watershed. Ecologically, there is a missing biodiversity in North Centre Timor District (Indonesia) such as apel. Datta and Gosh (2015) explained many human resources did not fuly understand the importance of biodiversity conservation and ecosystem management.They certainly acknowledge the contributions of the different biota in the Duma wetland in their livelihood sustainance. Economically, communities on Oecussi (Timor-Leste) gain more benefit from Tono Watershed in compared to North Centre Timor District (Indonesia). Tono Watershed is the main source for paddy field to Oecussi. Total paddy fields in Oecussi is about 1.300 ha, compared to 80 ha paddy fileds in North Centre Timor District (Indonesia).

Stakeholders' perceptions influence their roles in watershed management. Actors who play a role in the agreement, watershed forum and the autonomous transboundary watershed management respectevely: government, community, and expert. The government has authority to set the rules, to establish institution for planning, implementation and control of transboundary watershed towards sustainable development. University conducts research which in turn is used by the government and NGO to increase local community capacity. And business actors develop strategic partnership with community who manages the watershed individually and communally. Sriburi (2008) explained all stakeholders need to play actively and strictly committ.

The priority of institutional model of transboundary watershed management on sustainable development The results of the priority analysis of the watershed management institution model with AHP demonstrated that 53.60% of the priority focused on collaboration agreements of the Tono Watershed management. The establishment of a transboundary watershed forum was 35.20%, and the autonomous of a transboundary watershed management institution was 8.50%. The results of the weighting scale of the institutional model of transboundary watershed management toward sustainable development is depicted in Figure 3. Transboundary institution model of Tono Watershed management toward sustainable development was in line with the development phases, the community characteristics, and environment. This accordance with the study of Mumme (2010) stated that the institutional of transboundary watershed management has relation with development phases, condition of local community and environment. Therefore, it requires fixed calculations of water needs and conservation efforts. As example: The Rio Grande Watershed Management (The USA and Mexico) was based on 4 development phases: development and growth, sustainable development, protection of sustainable water resources, sustainable development of security and sovereignty.

Priority institutional model of transboundary watershed management, is also institutional stage in order to realize sustainable development on border area of Indonesia and Timor-Leste. Collaboration agreements of watershed management need strengthening capacity building of government and community to know the linkages of watershed zones (upperstream, midstream and downstream) and component of sustainable development (ecology, social, and economy).

The establishment of a watershed forum was necessary to conduct researches and coordination of the transboundary watershed management institution. The transboundary watershed management institution has the authority to adjust the regulations which stakeholders-binding (in Indonesia and Timor-Leste) for realized mitigation, adaptation and development bilateral based. Wondwosen (2008) reported that the countries within the Nile Valley established an institution to manage the Nile Watershed in 1999 and obtained international legitimacy in 2003. Decision making by the council of ministers as decission maker after receiving technical consideration from at least 2 experts from each countries.

The road map of institutional model of transboundary watershed management toward sustainable development Transboundary watershed management on Tono Watershed, needs a road map based on development phases, characteristics of the community, and environment. As Mumme (2010) stated that the policies and actions in each institution of development phase were different. The road map of institutional model of the Tono Watershed management institutions consist of: (i) institutional position in each country's institution, (ii) stakeholders involvement, (iii) actions taken, (iv) institutional funding, (v) the results achievement. As Ananda and Proctor (2013) stated that analysis of government institutional consists of constitution, regulations for collective action, and operational regulations. The road map for institutional model presented in Table 8.

JMHT Vol. 22, (1): 35–46, April 2016
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Scientific Article
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Table 7 Valuation result of benefits received actors on Tono Watershed

Benefit	Weight	Priority
Social		
RI's community	0,369	2
TL 's community	0,386	1
RI 's government	0,112	3
Tl's government	0,079	4
Expert	0,054	5
Ecology		
RI's community	0,410	1
Tl's community	0,343	2
Ri's government	0,123	3
Tl's government	0,066	4
Expert	0,058	5
Economy		
RI's community	0,352	2
TL 's community	0,390	1
Ri's government	0,106	3
Tl's government	0,097	4
Expert	0,055	5

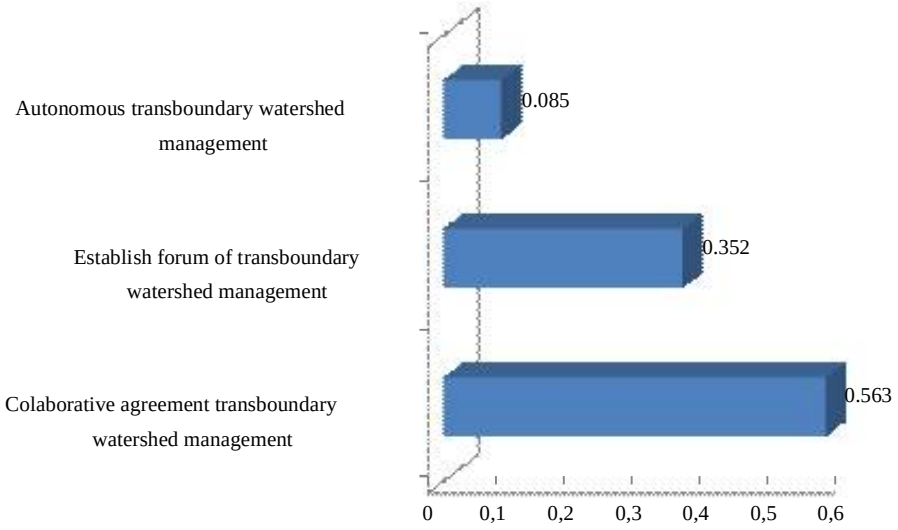

Figure 3 The results of the priority weighting scale of the institutional model of transboundary watershed management toward sustainable development.

Agreements for collaboration between Indonesia and Timor-Leste pushed each country to prepare a budget for each territory management independently. The actors of cooperation agreements were dominated by government. Then, equality of government, community and observers in the JBC (joint border committe) could establish watershed forum which supported by state-sharing budget mechanism. The watershed forum was the frontrier of the Indonesia and Timor-Leste for transboundary watershed management institution until it receives international acknowledgement. Wondwosen (2008) reported that the Nile Watershed institution received an international legal status in 2003 after obeyed a long-term process.

Each institution implement another strategies and action, to determined the success of watershed management toward sustainable development. Strengthening the government and local community capacity building, mitigation and adaptation, and develope collective actions leaded to achieve the sustainable development in boder area between Indonesia and Timor-Leste based on watershed management. As has

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been done by USA and Mexico in the management of the Rio Grande watershed (Parcher *et al.* 2010). Then, forth coming assessment needs to be conducted to reinforce the watershed management, similiarly, as recommended by McKee (2010) for the Jordan Watershed Management as a transboundary watershed: economy, politics, environmental, institutional, the distribution of water for agricultural and urban.

Conclusion

Resources of Tono Watershed were managed by Indonesian and Timor-Leste governments institutions separately, without coordination among them into integrated watershed's resources management. Weighted internal and external factors shows solution in Quadrant III is alternaltive institutional model of transboundary watershed management. Transboundary watershed management institution of Indonesian and Timor-Leste and stakeholders supports are needed to develop Tono Watershed sustainably. Transboundary institution model of Tono Watershed management toward sustainable development was based on development phases, community characteristics, and environment of Tono Watershed, as follows: (i) collaboration agreement between Indonesia and Timor-Leste government, (ii) establishment of a transboundary forum in joint border committe (JBC) of Indonesia and Timor-Leste, (iii) and construct the autonomous rights for transboundary institution Indonesia and Timor-Leste. The institutional model could be actions through: (i) strengthening the government and local community capacity building in the border area, (ii) mitigation and adaptation based collaborative approach between Indonesia and Timor-Leste, (iii) collective action to protecting common property (especially water resources and forest resources) are done through punishment as known as *banul/tarabandu*. *Tarabandu* is a form of disincentives that has been implemented in communities to protect water resources and forest resources on Tono Watershed.

Recommendations

Sustainable development in border area is the responsibility of all stakeholders. Development activities have impacted on sustainability of development in both Indonesia and Timor-Leste. The Government needs to conduct a holistic approach to achieve sustainable development of border area including ecological, social, and economic. The design of a transboundary watershed management institutions towards sustainable development and formulation of policies need to (i) consider an environmental-friendly agriculture by reducing slash and burn farming, (ii) to strengthen the cultures of forest and water protection such as protection of forest and water resource using indegenious rule (*banut/tarabandu),* (iii) suggest that an incentives to maintain the sustainability of water resources and forest resources, (iv) to do research to provide recommendations for collective actions by the stakeholders in Indonesia and Timor-Leste.

Table 8 The road map of institutional model of transboundary watershed management

Components	Collaboration	Watershed forum	Watershed management institution
The institutional position	The ministry of forestry of each country	Indepe ndent institutions formed by both countries	An autonomous institution formed by both countries
Stakeholders/Actors	Domination of Indonesia and Timor-Leste governments, community, and watershed observers	Equality of the government, community, and watershed observers	Equality of the government, public, and watershed observers
Actions	Government and community capacity building	A collaborative approach on mitigation and adaption	A collaborative approach on mitigation and adaption, collaborative business management (integrated between upstream, midlestream, and downstream)
Funding	The government of Indonesia in Indonesian territory and government of Timor Leste in Timorese territory	Co-funding (the Indonesian Government and the Timorese Government)	Co-funding (the Indonesian Government and the Timorese Government, and international donor institutions)
Results	MoU and transboundary watershed management plans	Control over transboundary watershed management in the frame of sustainable development	Full authority over transboundary watershed management in the sustainable development frame
Reporting mechanism	The ministry of forestry of each country and discussed in JBC Indonesia and Timor-Leste	JBC Indonesia and Timor-Leste	JBC Indonesia and Timor-Leste, and international donor institutions
Time target	The first and second year	The third and fourth year	The fifth year and so forth

References

Ananda J, Proctor W. 2013. Collaborative approaches to water management and planning: An institutional perspective. *Ecological Economics* 86:97−106. http://dx.doi.org/10.1016/j.ecolecon.2012.10.018.

Cosens B. 2010. Transboundary river governance in the face of uncertainty: Resilience theory and the Columbia River Treaty. *Journal of Land, Resources and Environmental Law* 30(2):229−265.

Datta D, Gosh PK. 2015. Evaluating sustainability of community endeavours in an Indian floodplain wetland using multi-criteria decision analysis. *Singapore Journal of Tropical Geography* 36(1):38−56. http://dx.doi.org/10.1111/sjtg.12092.

De Jong W. 2008. *Transborder Environmental and Natural Resource Management*. Kyoto: Center for Integrated Area Studies-Kyoto University.

[EU] European Union. 2000. *Directive 2000/60/EC:EU Water Framework Directive*. Brussels: European Commision Environtment.

Fauzi A. 2010. *Economic of Natural Resource and Environment, Theory and Application*. Jakarta: PT Gramedia Pustaka Utama.

Government of Timor-Leste. 2000. Konstituisaun Republika Demokratika Timor-Leste. Dili: Government of Timor-Leste. http://chg-ftpout.geog.ucsb.edu/puborg/chg/products/CHIRPS-2.0/global-monthly/tifs/ and http://iridl.ldeo.columbia.edu/SOURCES/.UEA/.CRU/.TS3p0/

Lautze J, Giordano M. 2005. Transboundary water law in Africa: Development, nature, and geography. *Journal of Natural Resources Management* 45:1053−1087.

Kartodihadjo H, Murtilaksono M, Sudadi U. 2004. *Institution of Watershed Management: Concept and Policy Analysis Introdution*. Bogor: Faculty of Forestry-Bogor Agricultural University.

Karyana A. 2007. Analysis of position and role of institutional development and at watershed (DAS) Ciliwung [dissertation]. Bogor: Bogor Agricultural University.

Keller J, Keller A, Davids G. 1998. River basin development phases and implications of closure. *Journal of Applied Irrigation Science* 33(2):145−163.

Kerr J. 2007. Watershed management: Lessons from common property theory. *International Journal of the Commons*1(1):89−109. http://dx.doi.org/10.18352/ijc.8.

Kodoatie RJ, Sjarief R. 2010. *Water Spatial Planning*. Yogyakarta: Andi.

Kontjraningrat. 2009. *Introduction of Antropology Science*. Jakarta: PT Gramedia.

Lusiana B, Widodo R, Mulyoutami E, Nugroho DA, van Noorwidjk M. 2008. *Assessment of Hyrology in Talau Watershed, Belu Regency, East Nusa Tenggara*. Bogor: World Agroforestry Centre. http://dx.doi.org/10.5716/WP15431.PDF.

McKee Mac. 2010. Future solutions: Research needs in the jordan river watershed. *Journal of Transboundary Water Resources* 01:179−187.

Mumme SP. 2010. Environmental governance in the rio grande watershed: Binational institutions and the transboundary water crisis: An agenda for strengthening binational water governance along the Rio Grande. *Journal of Transboundary Water Resources* 01:43−67.

[MoPW] Ministry of Public Work. 2007. Act Number 26 Year 2007 about Spatial Planning. Jakarta: Ministry of Public Work.

Prawiranegara M. 2014. Spatial multi-criteria analysis (SMCA) for basin-wide flood risk assessment as a tool for improving spatial planning and urban resilience policy making: A Case study of Marikina River Basin, Metro Manila-Philippines. *Proedia-Social and Behavioral Science* 135:18−24. http://dx.doi.org/10.1016/j.sbspro.2014.07.319.

Paimin, Pramono IB, Purwanto, Indrawati DR. 2012. *Watershed Managament Planning System. Center of Research and Development of Conservation and Rehabilitation, Research and Development Instituton of Forestry, Ministry of Forestry, Indonesia*. Bogor: Research Institution of Forestry Technology Watershed Management (BPTKPDAS).

Parcher JW, Woodward DG, Dural RA. 2010. A descriptive overview of the rio grande-rio bravo watershed: The physical and cultural surroundings of the transboundary watershed of the fifth longest river in north america is challenged by environmental issues which require collaborative technical solutions developed in alliance by U.S. and Mexican Scientists. *Journal of Transboundary Water Resources* 01:159−177.

Oii Chan-Seng, Richard EK. 2010. Culture, work and emotion culture unbound: *Journal of Current Culture Research* 2:303−310.

Rangkuti F. 2006. *SWOT Analysis Technique to Dissect the business case: the Reorientation of the Concept of Strategic Planning to Face the 21st Century*. Jakarta: PT Gramedia Pustaka Utama.

[RI] Republic Indonesia Government. 2012. *Act Number 37 Year 2012 about Watershed Management*. Jakarta: Republic of Indonesia.

Rosa H, Kandel S, Dimas L. 2004. Compensation for

Ecolosystem Services and Rural Communities: Lessons from the Americas. http://www.prisma.org.sv.

Rustiadi E, Saefulhakim S, Panuju DR. 2011. *Planning and Regional Development*. Bogor: Indopress.

Saaty T. 1993. *Desicion Making for Leader: Analitical Hierarchy Process For Desicion Making In Complex Situation*. Jakarta: PT Pustaka Binaman Pressindo.

Santoso EB, Erli HKDM, Aulia BU, Ghozali A. 2014. Concept of carrying capacity: Challenges in spatial planning (Case study of East Java Province, Indonesia). *Procedia-Social and Behavioral Sciences* 135:130–135. http://dx.doi.org/10.1016/j.sbspro.2014.07.336.

Schernewski G, Löser N, Sekścińska A. 2005. Integrated coastal area and river basin management (ICARM): The Oder/Odra Case Study. *Coastline Reports* 6:43−54.

Sriburi T. 2008. Transborder environmental management in the east-west economic corridor project. In: *Transborder and Natural Resources Manajemen*. Japan: Centre for Integrated Area Studies-Kyoto University.

Sudarmalik, Kartodiharjo H, Soedomo S, Adiwibowo S. 2014. The State and development of industrial plantation forest. *Jurnal Manajemen Hutan Tropika* 20(3):159−166. http://dx.doi.org/10.7226/jtfm.20.3.159

Taena W, Rustiadi E, Hariyoga H. 2013. Stakeholder perseption about economic development study on boundary area of North Centre Timor Regency and Oecussi enclave district. *Forum Pascasarjana* 36(4):215−232.

[UN] The United Nations. *The Future We Want*. *www.un.org/futurewewant.*

[WCED] The Word Commission on Environment and Development. 1987. *Our Common Future.* Oxford: Oxford University.

[UNDP] United Nations Development Programme. 2004. *Adaptation Policy Frameworks for Climate Changes: Developing Strategies, Polices, and Measures*. New York: Cambridge University Press.

Wondwosen TB. 2008. Transboundary water cooperation in Africa: The case of the Nile Basin Initiative (NBI). *Alternatives: Turkish Journal of International Relations* 7 (4):34−43.

Yu Chien-Hwa, Chen Ching Ho, Lin Cheng Fang, Liaw Shiu-Liang. 2004. Development of system dynamic model for sustainable land use management. *Journal of Chinese Institute of Engineers* 26(5):607−618.