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ABSTRACT
Citarum River is the longest river in West Java that due to industrialization, illegal logging and population explosion become one of the ten dirtiest rivers in the world. Efforts to restore the Citarum river condition hampered due to conflicts among stakeholders. This research proposed an agent-based simulation of negotiation process among stakeholders in Citarum River Basin conflict based on the drama theory framework. Agents in this simulation are equipped with emotional states and ability to learn. Using this simulation the dynamics during the negotiation and possible outcomes of the negotiation can be analyzed.

INTRODUCTION

Citarum River is the longest river in West Java province. Citarum River Basin has an area of 6.080 km^2 across three provinces namely West Java, Banten and DKI Jakarta. In the past, Citarum River can provide the community needs such as clean water, power generation, fisheries, tourism and recreation. Many people depend on the Citarum River, making it one of the most strategic river in Indonesia. Unfortunately, the condition Citarum River now has changed completely.

Since the industrialization in the 80s, the Citarum River turned into industrial landfills. Currently there are about 500 textile factories that dispose their waste into the Citarum River, many of which are conducted without proper waste treatment. Citarum River condition is worsened by the population explosion in the upstream area. Increasing population has also increased the number of illegal logging and disposal of household waste. As a result, flood always occurs during the rainy season due to sedimentation in downstream areas of rivers and increasing number of barren land.

Citarum River Basin Problem involves many stake holders i.e. the population and local governments in the upstream and downstream area, textile industry, and NGOs. These stakeholders have conflicting interests for example, NGOs urged people in upstream area to stop illegal logging, but this action will reduce community and local governments income. Because of these conflicting interests, efforts to restore the condition of Citarum River become futile.

Emotion and learning are integral parts in a negotiation to achieve conflict resolution. This study aims to analyze the steps that can be done to resolve conflict in the Citarum River Basin by constructing a negotiation model that involves emotion and learning. This model was developed by combining drama theory and PAD emotional model. Results obtained from this model are intractable, therefore the agent-based simulation was used to identify the combination of action and reaction between the parties that can eliminate the dilemmas and encourage collaborations.

DRAMA THEORY OF CITARUM RIVER BASIN CONFLICT

Drama theory is a problem structuring method, that use a metaphor of drama to describe a complex confrontation situations [1]. Confrontation situation is a situation that involves many stakeholders with different interests and, each stakeholders has different position for each interest. Based on the literature study and expert interview, there are six parties (agents) who participate in Citarum River Basin conflict i.e. local people in downstream, local people in upstream, textile industries, environmentalist (green), regencies in upper stream and cities in downstream.

Interaction among these parties produces a common reference frame, a view agreed by all parties about the problems they face [1]. A common reference frame contains options owned by each party, positions (whether a party agree or disagree toward an option), threat (fall back option) and options preferences of each party. By conducting literature review and expert interview, the following common reference frame of Citarum River basin conflict is constructed.

TABLE 1

OPTIONS OF PARTICIPANTS	THREAT	POSITIONS					
		USR	G	TI	DSP	USP	DSC
Up Stream Regencies						«	«
Stop deforestation	No	**Yes**	**Yes**	*Yes/No*	**Yes**	No	**Yes**
Green				»	«	»	«
Protest	**Yes**	No	No	No	*Yes/No*	No	No
Textile Industries			»		»		»
Stop un-treatment waste disposal to river	No	*Yes/No*	**Yes**	No	**Yes**	*Yes/No*	**Yes**
Down Stream People			«	«		«	«
Stop waste disposal to river	No	*Yes/No*	**Yes**	*Yes/No*	No	*Yes/No*	**Yes**
Up Stream People		»	»		»		»
Stop illegal lodging	No	**Yes**	**Yes**	*Yes/No*	**Yes**	No	**Yes**
Down Stream Cities		»	«	»	«	»	
Strict penalties for illegal waste disposal to river	**Yes**	*Yes/No*	**Yes**	No	No	*Yes/No*	No
Maintenance down Stream River	No	*Yes/No*	**Yes**	*Yes/No*	**Yes**	*Yes/No*	No
Reverse sharing to Up Stream Regencies	No	**Yes**	*Yes/ No*	*Yes/No*	*Yes/No*	*Yes/No*	No

To build a simulation model of negotiation based on drama theory, the positions of each party must be converted into scores [5]. Position scores represent pay-off that will be obtained by a party when an option is accepted and when an option is rejected. Total pay-off when an option is accepted and pay-off when an option is rejected is 100. If a party is indifferent toward an option then pay-offs that will be obtained by that party both when that option is accepted and when that option is rejected are assumed to be zero.

In this study a party's threat is assumed as the most adverse position to other parties. For example, if party *i* choose to adopt its option and the number of other parties who accept party *i*'s option is greater than or equal to the number of other parties who reject party *i*'s option then party *i*'s threat is to reject its option and vise versa.

Using the above procedure dilemmas faced by all parties can be identified as the comparison of pay-offs that will be obtained by a party [5]. There are two kinds of dilemmas that are considered in this research, i.e. rejection dilemma and persuasion dilemma. Those dilemmas are defined as follow.

- If party *i*'s pay-off by adopting party *j*'s position is greater than or equal to party *i*'s pay-off to adopt its own threat then, party *i* has rejection dilemma toward party *j*.
- If party *i*'s pay-off by adopting party *j*'s position is less than or equal to party *i*'s pay-off to adopt its own threat then, party *j* has persuasion dilemma toward party *i*.

NEGOTIATION PROTOCOL

In this negotiation protocol, each party is equipped with emotion that is modeled using PAD temperament model [3]. In this model, emotional state is constructed by three independent dimensions i.e. pleasure arousal and dominance. The formulation of party's emotional state is as the following [2].

$$Se_{ij}(r_p, r_a, r_d) = r_p.(1 + r_a) - r_d \quad (1)$$

During the simulation parties will conduct negotiation toward an option if there are incompatible positions (e.g. party *i* accept the option while party *j* reject the option) among them. The negotiation protocol in this research is constructed based on rational negotiation framework in which, party *i* will offer certain amount of its pay-off (st_i) in order to shift party's *j* position toward party *i* position. The potency of party's *i* offer to shift party *j's* position (Ov_{ij}) is affected by party *i*'s emotional state toward party *j* (Se_{ij}), and party *j*'s perception toward party *i*'s offer (Ov_{ji}) is affected by party *j*'s emotion toward party *i* (Se_{ji}).

$$Ov_{ij} = Se_{ij} \times st_i + st_i \quad (2)$$

$$Ov_{ji} = Se_{ji} \times Ov_{ij} + Ov_{ij} \quad (3)$$

Each time an offer from party *i* is perceived by party *j* then party *i* will compare the response of party *j* with the response of party *j* in the previous iteration. Then, party *i*'s emotion state toward party *j* will change according to the concept of Flow Model of Emotion [4] which then mapped into PAD dimensions.

TABLE 2

Party *i* offer (compare to previous iteration)	Party *j* perception (compare to previous iteration)	Change in party *i* emotion state toward party *j*		
		r_p	r_a	r_d
Higher	higher	+	+	+
Higher	lower	-	+	+
Lower	higher	+	+	-
Lower	lower	-	-	-

Through this negotiation process each party will learn to identify the emotional state that can produce the biggest shift in position of other parties (best emotional state). Learning mechanism which is built in this study is based upon the assumption that each party will revise his/her emotional state according to experiences his/her in previous iterations Each time party *i* give an offer to party *j*, party *i* will record emotional state that he/she use and the shift resulted in party *j's* position. If in the current iteration the shift in party *j*'s position is higher or equal to the shift in party *j*'s position in the previous iteration then, party *i* will revise his/her best emotional state according to his/her emotional state in the current iteration.

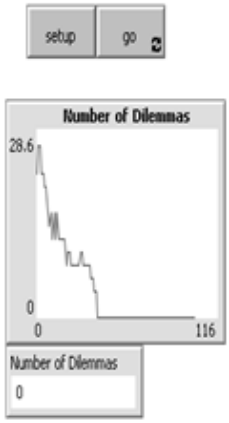
EXPERIMENT PROCESS

In the experiment process the simulation is run repeatedly. The results obtained in each simulation are

then grouped into two, zero dilemma condition and non-zero dilemma condition. Interactions among parties that will lead to each condition are then analyzed.

Zero Dilemma Condition

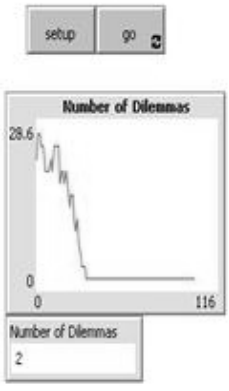
FIGURE 1



Based on the analysis, zero dilemma conditions most often achieved when all parties best emotional state are tend to be positive. Nevertheless, the zero dilemma condition may still be achieved even though there are some parties whose best emotional state tend to be negative toward the other parties. Provided that the party whose best emotional state tend to decrease, first received sufficient offer from several parties with relatively positive emotional state. In this case, it can be assumed that parties with relatively positive emotional state and compatible position formed an alliance to convince the party with negative emotional state to accept their position.

Non-Zero Dilemma Condition

FIGURE 2



Conditions in which there are some dilemmas remain mostly occur when there are several parties whose best emotional states tend to be negative. It also will be very difficult for a party who has very negative emotional state to achieve common position with party who has very positive emotional state. The negative emotional state will also eliminate the effect of alliances that have been mentioned in the previous section.

CONCLUSSION

Based on the simulation results can be identified several types of interactions that can eliminate dilemmas among parties in Citarum River Basin Conflict. The dilemmas among parties can be eliminated if all parties able to learn to use positive emotional state toward the other agents. The dilemmas are still possible to be eliminated although there are some parties who use negative emotional state. One kind of strategy in this condition is by forming an alliance. This alliance is easier to be initiated by party who has positive emotional state toward the other parties. After the initiator successfully creates common position with several other parties, they will be able to force party who has negative emotional state to accept their position.

Negative emotional state will inhibit parties to achieve common position. Especially, if the party to whom they are negotiating has very positive emotion. Negative emotion will also eliminate the effect of alliance. An alliance will be very difficult to force other parties to accept their position if at least one member of the alliance has very negative emotional state toward the party that is forced.

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