MODELLING OF SYSTEM DYNAMICS ON UPPER COURSE OF RIVER IN JAVA ISLAND, INDONESIA

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The Sustainability of a Watershed ecology depends on numerous factors, especially land and water availability. Transformation occurring on a watershed can be seen from the forest openings in the upstream to the conversion of rice fields into settlements and industrial areas in the downstream. The transformation determines the water cycle of watershed, such as absorbency, thereby affecting the river's water flow and quality. Mismanagement on the upstream area, in addition, may affect the downstream area.

This paper is aimed to observe and understand the occurring transformations of watershed in Java Island - Indonesia. Furthermore, this paper will be related to the sociological and economical aspects at the community in the river upper course in the north coast of Java. Thus, it will provide the basic consideration for well-managed watershed by integrated System Dynamics program applied to support the analysis.

1. INTRODUCTION

Development of downstream watershed of Jakarta north coast is an expansion of Jakarta area to the north coast direction which includes an area of 87.5 km2. The development of this area is expected to become a water front city. In addition to becoming the alternative of settlement which is difficult to be more expanded to other areas, the development of Jakarta north coast has an additional value, especially for the office complex and tourism.

The transformation of downstream watershed areas will cause the change of stability on such areas. With the expanding of coastal surface area, then the condition of river estuary which initially has the direct contact to the sea is becoming the river body. Consequently, the area physical condition which is initially fertile for biota requiring estuary/inlet water as their life media will be shifting, and to return to the condition at which the biota can live will require a long time.

2. MODEL FRAME

To know the cycle of land surface addition and reduction as well as the housing availability which is the most potential stimulant of the coastal area expansion (reclamation), then it is necessary to build the structural relationship picturing the behaviour of such areas. This behaviour picture is expected to reflect the logical relationship between the systems visible inside. Hence this model can be used to determine the coastline structural dynamics (the downstream watershed area).

Simulation of the downstream watershed area dynamics is built by using a dynamics method, a model which illustrate the causality relationship of all system constituting factors as a basis to know and understand the behaviour of system dynamics.

4. 1. GENERAL MODEL FRAME

This model consists of several sub-systems, those are : firstly, land surface; secondly, investment for reclamation; thirdly, settlement development. On the sub-system of land surface the model will be built by two loops, both are negative loops (Figure 1). Negative loop is a loop functioning as the controller. The output of this negative loop is directed to the equilibrium if it is combined with the positive loop (ARCHTYPE System, Pegasus 1996). The graphical output from this two negative loops are the drifting goals.

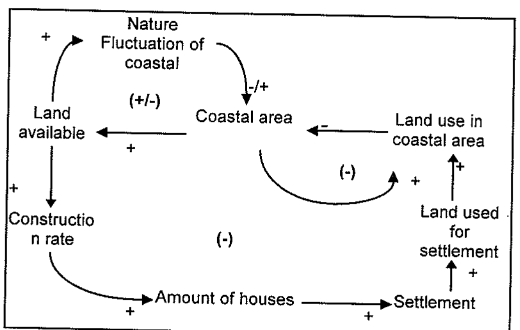

Figure 1. Sub-Model Structure of Land Surface Area

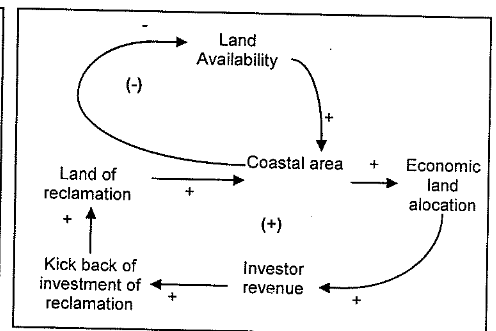

Figure 2. Frame of Investment Sub-Model Structure

The first loop is an availability of land surface which functions as settlement areas. Firstly, land surface will decrease and increase naturally because of abrasion and accretion. This cycle is not included in the drifting goals pattern because the accumulation of land surface transformation caused by this cycle is near zero. Secondly, land surface will experience a transformation due to human activities as shown on Figure 1. Decreasing land surface area does not mean that the land is used up, as happening during abrasion. Land surface area is increasing because of reclamation. Progressively that the reclamation will cause the land surface increasing which will then increase the land available. Such conditions will then directly increase the settlement development on such areas by which the number of houses will also increase. From the existing number of houses, then it will encourage the desire to expand the settlement area by which the land area will be reduced. The second loop is land surface area with the land utilisation. The increasing land surface area will cause the land utilisation also increases, in other hand however, the more land area utilised then land surface area will be narrower or reduced. Therefore the system will point to the goal seeking or approach the constrain.

4.1. INVESTMENT SUB-SYSTEM

This investment sub-system is built in two loops (Figure 2), positive loop and negative loop. The graphical output is fixes that fail. The first loop is an interaction between investment and land surface area. In this positive loop the increasing land surface area will cause the increasing of economical land allocation. This increasing economical land can be done quantitatively or qualitatively. The quantitative increasing means that the increase automatically happens if the land surface area increases, while the qualitative increasing of economical land is because the improvement of human ability with the technology to increase its economical value. The increasing economical value of a land will then add the investor revenue.

On this land utilisation loop, the wider land utilisation or the wider area recommended for the reclamation area, then the land surface area will be wider. Meanwhile, the wider the land surface area then the area of land utilisation will be more used-up or reduced to near zero. The system analysis stated that this sub-model interaction pattern is Fixes that files, therefore even though the decision to limit this area is accomplished, but the main problem that the reclamation rate is increasing will happen. Furthermore result of behaviour pattern of this model show in the figure 3 & figure 4.

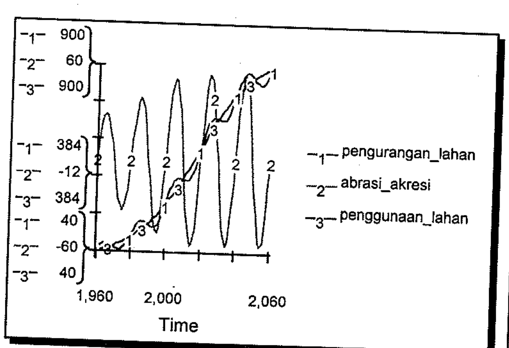

Figure 3. Influence of Abrasion and Accretion to the Land Reduction

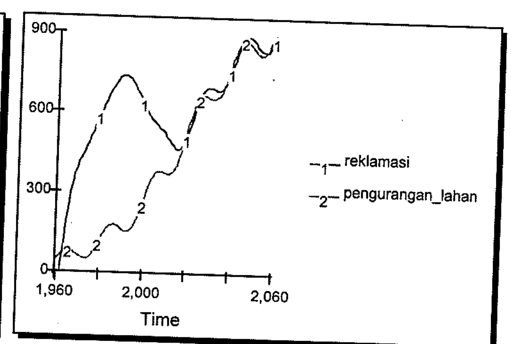

Figure 4. Rate Similarity Pattern on Land Surface

5. POLICY ANALYSIS AND CHOICE

After the reference scenarios being determined, then the policy analysis is performed. The analysis result is used as the consideration basis to determine the policy choice. The policy formulated in this simulation including :

1. *Policy of Land Utilisation*

The reclamation activity will cause impacts for biota in such an area and areas surrounding the reclamation area. The additional land area will cause the wave hindered on such areas. Therefore it is possible that the surrounding area will experience the increasing sea water. On the other side, the change of river estuary will happen

2. *Technology Policy*

This technology is directly correlated to the investment. With the large capital to be invested, then it will not only affect the time needed for reclamation, but also will affect the land surface area

3. Settlement Policy

CONCLUSION

- The model of settlement cycle directs to *Limit to success,* i.e. the settlement growth is always limited by the limitation of land available.
- The reclamation activity performed without any strict area planning and regulations will cause the problem which cause the loss to the activity itself in long term, such as the case of fixes that files.
- The reclamation activity is the drifting goals activity. The system which is expected to solve the settlement problem, but in long term - if there is not strict regulations- will be the environmental problem evolving later.

REFERENCES

1. Kim. H.,Daniel. *ArchType Tools*, Pegasus, Cambridge, Massachusetts, 1996.
2. Meadows, Dennis L. and Meadows, Donella H. *Toward Global Equilibrium*, Wright Allen Press, Cambridge, Massachusetts, 1973.
3. Richardson, George P. and Alexander L, III. *Introduction to System Dynamic Modelling with Dynamo*, Cambridge, Massachusetts: MIT Press, 1983.
4. Senge, Peter. Disiplin Kelima, Translation of *Fifth Discipline*, Bina Aksara, Jakarta, 1996.