A Conceptual Framework for a Dynamic Model for Regional Planning: Towards Sustainable Development for Bali, Indonesia

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ABSTRACT: *The tourism boom in Bali in the '90s resulted in tourism becoming the major component of economic development. However, as a small island, the capacity of Bali to enhance its development is dictated largely by natural resource limitations. Development planning for Bali should recognise such limitations and, in addition, adopt a holistic view of the bio-physical and socio-demographic conditions. A dynamic model within a systems-thinking framework is considered beneficial both as a pedagogic device in understanding how various island-based systems function and as a useful tool in assisting decision-makers in development planning. This paper outlines a conceptual systems dynamics model for an island system based on the mental models of knowledgeable government officials and stakeholders elicited through interviews, seminars and a workshop.*

Keywords: systems thinking, system dynamics, strategic planning, island development, sustainable development.

INTRODUCTION

The use of a systems-thinking approach in the development planning process (involving the creation of a system dynamics model) has been given increasing attention in recent years. The first steps in this process commonly include *initial scoping* and *consensus building*. Key stakeholders, including local community representatives, were involved in the initial scoping stage (through both interview and workshop involvement) in order to identify important aspects of development for Bali. Key stakeholders also participated in the consensus building stage, in order to develop a conceptual systems model. In this stage, various views about the important system parameters (reflecting the various stakeholder backgrounds) were discussed in a two-day workshop. The use of this systems-thinking approach has resulted in a road map for the development of a system dynamics model, the conceptual framework of which is outlined in this paper.

DEVELOPMENT ON BALI ISLAND

Economic Development

Bali is a relatively small island (5,633 km^2) with fertile agricultural strips along the south-central area where abundant rice crops are grown. Bali's population increased from about 1.5 million in 1950 to about 3 million in 1998, with the majority of the population being Hindu. In 1969 Bali's economy was basically agrarian with the agricultural sector contributing about 61% of the Gross Regional Domestic Product (GRDP). As tourism developed in Bali, agriculture's share of GRDP decreased from about 36% in 1983 to about 19% in 1997, while the trade and tourism sector (hotels and restaurants only) increased its share from about 10% in 1969 to about 31% in 1997 (BPS Bali various issues). Thus tourism has become the leading sector in Bali's economy. However, the majority (about 74%) of Balinese still live in rural areas working in the agricultural sector and as rural artists working on various traditional arts or producing crafts predominantly for the tourism market.

The development of tourism in Bali increased in terms of the number of visitors and the number of tourism facilities. The numbers of direct arrivals of foreign visitors in Bali increased from 24,340 in 1970 to 1,187,153 tourists in 1998 (BPS Bali various issues). However, it is impossible to obtain the total number of tourists visiting Bali due to the absence of data on foreign tourists arriving in Bali via other regions of Indonesia and also the absence of data on domestic tourists. An estimate of the *total* number of tourists visiting Bali in 1998 is about 4 million. As the number of tourists visiting Bali increased, the number of tourist accommodation also increased to 18 464 rooms in 1997 (BPS Bali various issues). Tourism has boosted the regional economy through tourist spending, which was estimated to create multiplier effects of about 2.2 for the total production sectors (Antara 1999). As tourism developed, GRDP per capita increased significantly from 1,090,400 rupiahs in 1990 to

4,575,100 rupiahs in 1998 demonstrating that Bali is enjoying the economic benefits of tourism (BPS Bali various issues).

Small Island and Sustainable Development

(a) Nature of Small Island's Resources

In terms of development, small islands have special characteristics relating to their economies, natural resources, and socio-cultures (Fuavao 1995, Beller et al. 1990, Kakazu 1994). Small island economies are less diversified and more specialized than other economies in that they are mostly based initially on natural resource-based activities (particularly primary sectors such as agriculture and fisheries) and later on tertiary sectors (such as tourism). Island economies also suffer from diseconomies of scale in production, consumption and investment (Kakazu 1994) and as a consequence, it is difficult to achieve a reasonable level of economic growth.

Insulation is the most significant characteristic of island natural resources, which include water and power supplies, vegetation, wildlife, land, and coastal areas. Water is the ultimate factor in determining island development potential since much freshwater is lost directly to the sea as a consequence of generally small and sloping water-catchment areas. Moreover, in dry regions, the limited water-retaining capacity of islands makes them particularly drought sensitive (Beller et al. 1990). Due to critical water shortages in Bali during the dry season, competition for clean water has emerged, particularly with respect to residential and tourism activities. As a result, many hotels exploit the ground water in excess of annual recharge, leading to salt-water intrusion of the island (Martopo and Mitchell 1995).

As small islands experience rapid population growth and urbanization, increasing population pressure on limited land leads to the transformation of agricultural land into non-agricultural purposes. In Bali, a rapid growth in tourism and urbanization has resulted in high quality agricultural land being used for residential, tourism and other commercial facilities (Martopo and Mitchell 1995), raising the question of the island's capability to sustain rice production and maintain its distinctive culture related to its agricultural practices. In addition, land conversions disturb the natural environment with consequential detrimental impact on downstream ecosystems.

Another important factor for small-island development is the availability of supporting infrastructures, such as waste disposal and power supply. Most small islands have inadequate facilities for the disposal of solid waste and treatment of wastewater, resulting in the pollution of fresh and coastal waters (Beller, et al. 1990). The provision of adequate supplies of energy (especially electricity), appropriate solid waste disposal, and wastewater treatment for island development requires relatively expensive capital investment and depends substantially on imported equipment and fuels. As island economies suffer from diseconomies of scale in production, consumption and investment, their ability to provide the supporting infrastructures is limited (Kakazu 1994).

Taking these all above considerations into account, it is clear that sustainable island development is unlikely unless appropriate development planning is undertaken.

(b) Sustainable Development

The concept of *sustainable development*, that is, 'meeting the needs of the present without compromising the ability of future generations to meet their own needs' has been widely acknowledged since its appearance in 'Our Common Future' (WCED 1987). Sustainable development includes maintaining ecological integrity and diversity, meeting basic human needs, keeping options open for future generations, reducing injustice, and increasing self-determination. The concept of sustainability may be used as a guide to island development though in this context, more attention should be given to natural resources, traditional resource uses and conservation practices, and the socio-demographic aspect (Martopo and Mitchell 1995). To be practical, however, the issues of the sustainable development of Bali Island may be specifically oriented to critical aspects, such as water and land resources, and management of waste; all related to major economic activities (tourism and agriculture) and population. Furthermore, development planning should also identify societal needs and aspirations. Though difficult to assess quantitatively, this aspect can be incorporated into the development planning process through public participation and stakeholders' involvement.

System Dynamics Model as a Tool for Development Planning

Sustainable development options should encompass many aspects including economy, demography, environment, and socio-cultural issues. The complexity of these interrelated aspects and resulting competition/conflict leads to difficulties in understanding the processes and in anticipating the future. One possible solution is to adopt a holistic approach within the development planning process facilitating an

understanding of interactions among different aspects. A holistic approach can be achieved through systems thinking, which emphasises the inter-relations among the various parts that constitute a whole system.

To simplify complex real-world phenomena in the development planning process, a model, as a real-world abstraction, is used. A model should represent a good understanding of the problems and their interdependence within the real-world system. A system dynamics model is one way to do this, and can exhibit the inter-relation amongst subsystems within the system, and between components of subsystems, involving feedback interactions (see Beller, et al. 1990, Bergh 1991). System dynamics models have been recognised to contribute much to an improvement of the decision-making process in strategic planning through a policy analysis by allowing the simulation of policy scenarios (Saeed 1994). Using a system dynamics model, behaviour (character and nature) of the system can be easily understood, and it is possible to explore all plausible development options through evaluation of the behaviour of the model given particular scenarios (Forrester 1987).

KNOWLEDGE ELICITATION PROCESSES AND RESULTS

Costanza and Ruth (1998) propose three stages for developing models from an *initial scoping and consensus building* stage, to a more quantitative *modelling* stage, and finally the development of a high level *management model*. This paper focuses on the first stage -initial scoping and consensus building, involving knowledge elicitation processes for the development of mental models. As a systems model should be developed from mental models obtained from stakeholders and experts with respect to subsystems, the first knowledge elicitation process was undertaken involving stakeholder/expert interviews and a seminar.

Initial Scoping: Problems and Issues of Development in Bali

From interviews undertaken with 32 respondents (Balinese experts, community leaders, and officials from NGOs) during the period of June-August 1998, main issues identified were: (i) an increasing impact of development (tourism) on Balinese socio-culture (particularly in terms of changing lifestyles towards more consumerism and individualism (i.e. less time for socio-cultural activities)) due to the influence of foreign tourists and/or their involvement in economic activities (tourism); (ii) uncontrolled land transformation due to the boom in tourism in Bali leading to rapid development of tourism facilities, tourist related businesses and residential areas. It was noted that thousands of hectares of fertile agricultural land have been converted to other uses (particularly tourism facilities, residential and commercial uses) in the last decade; (iii) the conflict of interests over the use of public spaces (especially beaches) between cultural-religious activities of Balinese society and tourist activities in some areas; (iv) limitations of natural resources (particularly land and water) and the conflict of interests in their use between economic and residential activities. In addition, issues of beach erosion, reef destruction, wastewater pollution, and solid waste disposal were identified; and (v) in-migration (recently referred to as an 'exodus') to Bali due to the recent Indonesian monetary crisis and riots on other Indonesian islands, resulting in socio-demographic problems (including emerging slum areas, increasing crime and prostitution, and social tensions between Balinese and migrants).

Summarizing these key issues, the systems dynamics model comprises three major subsystems: (a) the socio-demographic subsystem; (b) the economic subsystem; and (c) the natural resources subsystem, together with a 'dummy' development subsystem which facilitates indirect interactions between the three major subsystems through development activities (see **Figure 1**). The focus of the system dynamics model is on the interactions between economic activities, natural resources and socio-demographic factors, which relate to the carrying capacity of the island to absorb development activities and to fulfil human needs in order to achieve sustainable development.

Consensus Building Stage: Developing a Conceptual Systems Model

The second knowledge elicitation process was undertaken through an intensive two-day workshop. This followed the process for developing mental models for 'Modeling Dutch Health Care' (Vennix and Gubbels 1994). Three months before the workshop, various key institutions in establishing development planning policy for Bali were selected as participants. The participants represented government officials (the planning board, tourism, agriculture, industry, and forestry and conservation offices), practitioners (tourism, agribusiness, and industry), community leaders, NGOs, and some experts from Universities. Most participants (about 70%) were aware of the existence of systems thinking and dynamics modelling, but only a few (less than 20%) could be considered to have any significant knowledge in this respect. Preparation for the workshop involved supplying information about systems thinking and dynamics modelling, and requesting responses to questions relating to participant's perceptions on Bali's future.

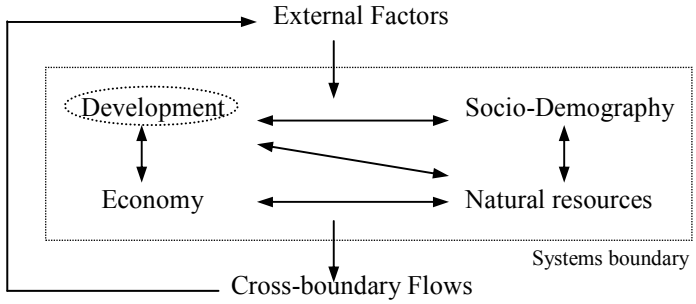

Figure 1. General framework for a regional-based systems model (Modified from Bergh 1991)

The workshop was critical in developing mental models, identifying important system components, and establishing general inter-relations between system components (represented in road maps). The road maps for an island system are given below.

(i) Economy and Natural Resources

As Bali has developed through on tourism and agriculture, the economic aspects of the model focus on these two economic activities, and on small-scale industry related to tourism and agriculture. The two main sectors compete for natural resources, particularly water and land resources, which are considered to be the two most significant development constraints. Availability and suitability of land resources with sufficient water supply will determine the sustainability of the agricultural sector. On the other hand, increasing tourism encourages further development of tourism facilities, including mega-resorts and golf courses (both of which consume large amounts of land and water). These inter-relations are illustrated in **Figure 2**.

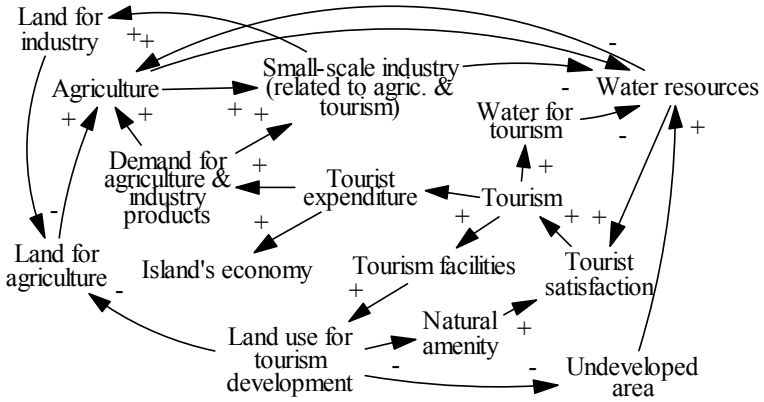

Figure 2. Road map of inter-relations between economic activities and natural resources

(ii) Socio-demography and Natural Resources

Increasing population results in increasing demand for housing, food and water, and an increase in waste and pollution. The consumption of water and land for residential uses affects the agricultural sector, especially the ability to maintain self-sufficient rice production. The production of waste and pollution also affects water resources, and will finally have an impact on the population (in terms of human health and mortality). These inter-relations are illustrated in **Figure 3**.

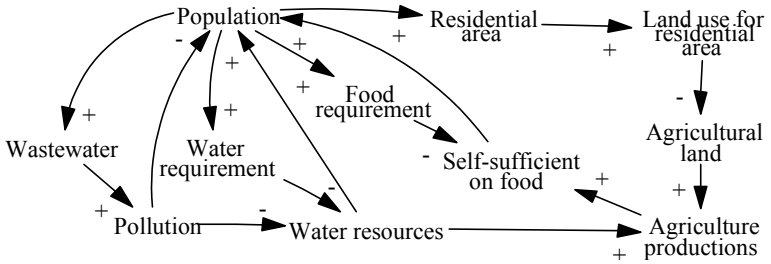

Figure 3. Road map of inter-relations between socio-demography and natural resources

(iii) Development and Socio-demography

Some inter-relations between economy and socio-demography involve development activities. The development of infrastructure (such as hospitals, schools, roads, and solid waste disposal, water and wastewater treatment facilities) affects human welfare, which then influences the region's attractiveness to migrants. The existence of migrants influences Balinese socio-cultural cohesiveness. Population and socio-cultural cohesiveness is closely

related to socio-demographic problems which then influence the process of development itself and human welfare. These inter-relations are illustrated in **Figure 4**.

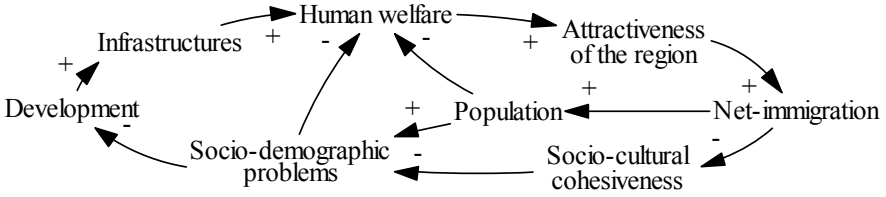

Figure 4. Road map of inter-relations between development and socio-demography

(iv) Development and Natural Resources

Interactions between the economy and natural resources do not always occur directly; some interactions involve development activities. The development of infrastructure affects the quantity and quality of natural resources, because the ability of natural resources to fulfil people's needs also relies upon man-made infrastructure. For example, the availability of water and wastewater treatment facilities is beneficial for water resources. However, development also affects the availability and suitability of land for future development, as well as impacting on the hydrological regime, which in turn affects water resources, especially groundwater stock. These inter-relations are illustrated in **Figure 5**.

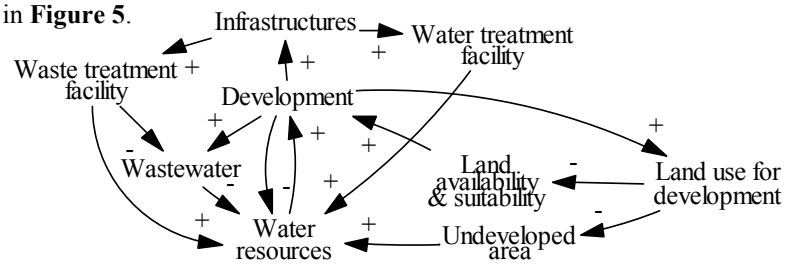

Figure 5. Road map of inter-relations between development and natural resources

(v) Development and Economy

Development activities generate job and business opportunities which then provide income for the people. Income influences the state of the regional economy through consumer spending. Finally, the island's economy will influence the business opportunities and development itself. These inter-relations are illustrated in **Figure 6**.

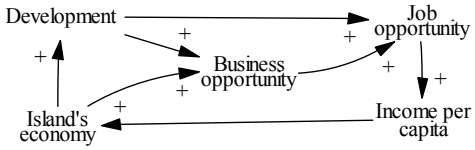

Figure 6. Road map of inter-relations between development and economy

(vi) Inter-relations amongst Subsystems within an Island System of Bali

Road maps representing cause-effect relations between subsystems within the island system were defined during a plenary workshop session (see **Figure 7**). Though Bali has limitation on development from the perspective of several natural resources, only land and water resources are included in this model, since the sources of energy are very broad and easier to obtain. Competition for the use of land and water resources for agriculture, residential activities and tourism are the focus of the model. Impact of land use change on groundwater stock is also incorporated into the model through a land-use and water sub-model. The more land is transformed and water allocated for settlement and tourism development, the less land and water is available for agriculture. If this trend continues, less agricultural products may be produced, raising a question whether or not Balinese culture could continue to be strongly based on an agrarian society.

The socio-demographic aspect of the island is represented by various parameters, including population, employment and migration. As foreign tourists are interested in people and culture (55.7%) and natural amenity (29.4%) (DIPARDA 1998), uncontrolled development of tourism may inhibit tourism itself. Feedback from development impacts on tourism via socio-demographics and natural resources are involved in the model.

A TOOL FOR DEVELOPMENT PLANNING: CONCLUDING REMARKS

The distinctive feature of Bali's economy related to the limitation of natural resources and bio-physical characteristics is given more significant attention in the model development, whereas the social aspect is simply represented through socio-demographic parameters. In order to capture the dynamic inter-relations between

economy, socio-demography and natural resources, the impacts of economic development on socio-demographics and natural resources, as well as the feedback notions from these impacts on the economic activities are incorporated in the model. To achieve sustainable development of the two major economic sectors, a balance between economy, natural resources, and socio-culture is important. As Bali's economy is driven by the tourism and agricultural sectors; and taking into account for the competing uses of limited natural resources, focus on the dynamics model may be given to the land and water resources.

The conceptual model is finally translated into a computer simulation model involving many parameters (levels, rates, delays and multipliers) using a dynamics simulation software. Here, *Vensim* has been adopted for computer implementation of the conceptual model. When the model is completed, 'what-if' scenarios will allow the user to assess the dynamic inter-relations between the economy, socio-demography and natural resources, and the capability of the natural resources to support future development. There will be a possibility of using a system dynamics model in assisting policy makers in establishing a strategic plan towards sustainable island development involving multi-stakeholders.

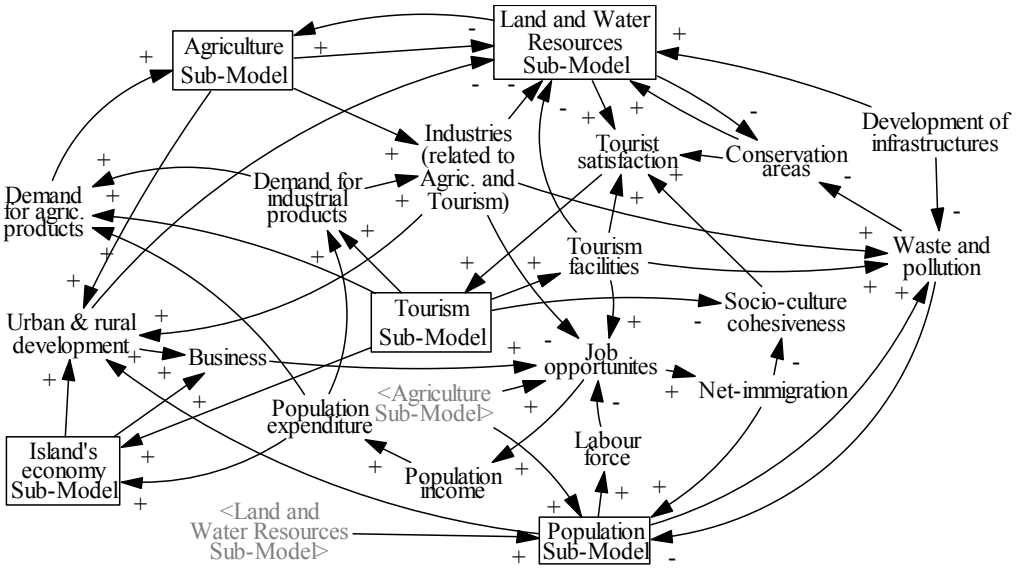

Figure 7. A conceptual system dynamics model for Bali

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