



TRITON

JURNAL MANAJEMEN SUMBERDAYA PERAIRAN

Volume 7, Nomor 1, April 2011

**ANALISIS PENGARUH KEBIJAKAN PEMERINTAH
TERHADAP PENGEMBANGAN KAWASAN PERIKANAN
DI KABUPATEN MALUKU TENGAH**

TEKNOLOGI PROSES PEGARAMAN DI INDONESIA

**VULNERABILITY INDICES AND
SUSTAINABLE DEVELOPMENT OF SMALL ISLANDS
THEIR UTILIZATION, USEFULNESS AND PROBLEMS : MALUKU CASE**

**KONSENTRASI KLOOROFIL-a PERMUKAAN
PERAIRAN TELUK AMBON DALAM**

**DISTRIBUSI STROMBIDAE DI ZONA INTERTIDAL
SEKITAR PERAIRAN PULAU-PULAU LEASE, MALUKU TENGAH**

**POLA SEBARAN SEDIMEN PANTAI PADA
PERAIRAN PANTAI HUTUMURI DAN WAYAME**

**PENGUJIAN SENSITIVITAS DAN EFEKTIVITAS ANTIBIOTIK
TERHADAP PENYAKIT VIBRIOSIS PADA
KERAPU TIKUS *Chromileptes altivelis***

**JURUSAN MANAJEMEN SUMBERDAYA PERAIRAN
FAKULTAS PERIKANAN DAN ILMU KELAUTAN
UNIVERSITAS PATTIMURA
AMBON**

TRITON

Vol. 7

No. 1

Hlm. 1-65

Ambon, April 2011

ISSN 1693-6493

VULNERABILITY INDICES AND SUSTAINABLE DEVELOPMENT OF SMALL ISLANDS THEIR UTILIZATION, USEFULNESS AND PROBLEMS: MALUKU CASE

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ABSTRACT: Small islands bring some inherent characteristics that make them vulnerable towards natural and anthropogenic disaster. Vulnerability indices that describe island ecosystem integrity which formerly develop by Small Island Developing States in response to climate change and sea level rise can be used as a precautionary principle tools and the sustainable development of small islands. Some indices that composed vulnerability indices *i.e.* environmental vulnerability index, economy vulnerability index, social vulnerability index *etc.* Considering data base availability and accuracy of the data in building such index, strictly examinations should be consider in order to have good indicator.

Keywords: small island, vulnerability index, sustainable development.

INTRINSIC CHARACTERISTIC AND POTENCY OF SMALL ISLANDS

There are some definitions used to describe the small islands *i.e.* Beller *et al.*, (1990); UNESCO (1994); Tresnadi (1998), all describe the small island with the size varies between 10,000 km² down to less than 100 km² with the population less than 500,000 people. In relation to the management of small island in Indonesia for sustainable development, the Ministry of Marine and Fishery Affairs of Indonesia had issued the decree KEPMEN Kelautan dan Perikanan No. 41, 2000 that describe the small island as an island with the size less than 10,000 km² and the population of less than 200,000 people. Other criterion commonly used to define small islands are ecological criteria – concerning endemic species and insularity; economic dependency on main land; and cultural uniqueness.

Small islands in general have some inherit characteristics which make them different from big island such as small in size, small in catchment area which lead to limited ground water resources, many endemic species, little carrying capacity, vulnerable to natural disaster such as tornado, flooding, land erosion, earthquake, pollution, sea level rise, insularity from main land which lead to very dependable economically on main land, less infrastructure such as school, market activity, bank, transportation (Adrianto and Matsuda, 2002; Wall, 2006; Howorth, 2002; Kaly *et al.*, 2003; Gowrie, 2003).

Pristine and tropical coastal habitats have long attracted tourists to small island developing states (SIDS) include all small islands apart from SIDS. Here one finds rich marine and coastal environments, diverse flora and fauna, and a wealth of natural resources. These natural attributes all play a critical role in sustaining the islands' communities and economies. With blue and clear seawater, white sandy beach, squirt of coral reefs surrounded by diverse color and exotic coral reef fishes and opaque of green mangrove forest, uniqueness culture has make this area a target for marine resort development. Barbados, Mauritania, Fiji are an example of small islands (state) that depend mostly on their marine environment.

Apart from its environmental beauty, small islands also have other resources such as minerals like nickel, copper, gold, off shore oil deposit. These are valuable natural resources for those island but very risky in sustainable development since most small islands are limited in their caring capacity. For their development (exploitation) one has to be very careful because it can have tremendous damage the environment of the island.

THREATEN AND VULNERABILITY OF SMALL ISLANDS

Regardless of their natural resources, small islands are fragile ecologically and economically. The natural environments of small islands include SIDS are thought to be susceptible to a range of natural and anthropogenic hazards that damage them at rates and intensities above those found elsewhere around the globe. Hazards are those events and processes that can adversely affect the biological integrity or the health of ecosystems. Because of their smallness, their human and natural environments have limited capacity to absorb shocks, tend to have few refugia. For the natural environment, the entities at risk, termed responders, include ecosystems, habitats, populations and communities of organisms, physical and biological processes (beach building, reproduction), energy flows, diversity, genes, ecological resilience and ecological redundancy. Each of these responders (ecosystem goods, services and relationships) may be affected by natural and anthropogenic hazards, the risk of which may vary with time, place and human behaviors. The complex nature of vulnerability has required the development of vulnerability theory to provide a framework for logical development and measurement (Howorth, 2002)

Vulnerability can be defined as the potential for attributes of any system, human or natural to respond adversely to events. Hazardous events are those that can lead to loss of diversity extent, quality and function of ecosystems. These changes are often described as damage to the biological integrity or health of ecosystems, and therefore their ability to keep supporting humans. These may include natural hazards as well as human pressures. Vulnerability to damage arises from a combination of the inherent characteristics of a country, the forces of nature and human use, including the special case of climate change. Vulnerability can provide a valuable indication of how sustainably humans are living within their environmental means through a dual focus (Howorth, 2002).

Natural environment of small island vulnerable towards several of hazardous event either natural or anthropogenic and can cause significant damage to the environment (Kaly *et al.*, 2003; Cherian, 2004). As consequences of its

smallness, the carrying capacity of small island is limited (Gowrie, 2003). With the increase of human population either through natural process (natality) or the increase in tourist's number (especially for SIDS), this in turn increase the pressure towards natural environment of small island. In longer term, if not manage properly; this may lead to environmental degradation.

Hall (1999) *in* Adrianto (2004; 2005) divide ecosystem characteristic and environment of small island in relation to environmental problems into two groups *i.e.* common environmental problems and local environmental problems. Common environmental problems is defined as common problem occurs in all small islands worldwide such as local sewage, fisheries, forestry and agriculture problems, land use management and development, property right. Commonly speaking, small island are threatened by sewage produced by local community and tourists if the island is a tourism site. Environmental degradation such as coral reefs destruction (destructive fishing activities), over fishing, mangrove forests deforestation, land erosion, coastal abrasion.

Local environmental problems faced by small islands are loss of land either physically or quality, lack of fresh water, solid sludge, poisonous chemical substances and endemic species. Land erosion that leads to land loss (quantity and quality) particularly in small islands is a serious problem for local farmer since they have limited land area. Land use management currently jeopardizing fresh water availability many small islands since many catchment areas have been switch over to settlement area and office and business. Small islands are prone to flooding, sea level rise and typhoon as human activities increase from time to time which contribute to global warming and climate change (Adrianto dan Matsuda, 2002; Wall, 2006). Sea level rise is predicted to increase at the rate of 0.8 mm to 2.0 mm year⁻¹ and happened threatening small islands around Pacific and Atlantic Ocean as well as Caribbean Sea (Nurse *et al.*, 2001).

The effect of damage to natural and environmental resources of small island will contribute to social and economic aspect of the community. Economically, small island especially the insular island will depend very much on main land. They are lack of infrastructure, less development, less in education. These will inevitable can cause social problems to the community. Small islands which are bordering with foreign country is even more susceptible if not manage properly.

THE NEED OF VULNERABILITY INDEX FOR SUSTAINABLE DEVELOPMENT OF SMALL ISLANDS

Realizing the complexity and threatening encountered by small island in particular the SIDS, the politician and decision maker realize the need of an indicator that can be short, rapid, and quite accurate in assessing the status and possibilities of threaten faced by small islands states (Briguglio, 2003a; 2003b). The interest of having kind of indicator that state the vulnerability of small island states firstly arise at United Nations conference held in Barbados (1994). This indicator termed as *Vulnerability Index* that combine ecological fragility and economy fragility. Environmental vulnerability concern with natural environmental damage of one state (island). The term vulnerable here means prone towards hazardous or damage from outside. Gowrie (2003) defines it as the potential of system attribute which react severely towards any destructive event.

The vulnerability index was developed on the basis of logical requirements for assessing the countries vulnerability, but it can be applied down to regional or even provincial level.

For common understanding, what is meant by risk here is the impact that associate with particular phenomenon that gives impact on particular community. The impact here define as destruction and loss (include death), and the phenomenon here define as disaster, How the disaster effect the community depend on vulnerability and resilience of the community (Briguglio, 2003b). In formal way, the risk can be formulized as:

$$R = H. P. V$$

where: R = Risk, that can be measure in different way, include number of death or the magnitude of economy loss or destruction; H = Hazard, that has probability unit (how far this event could take place), intensity dimension (high or low), frequency of repetition (often or seldom), spatial destruction dimension (area being affected), rapidity dimension; P = Population being affected or population live at an area expose to the disaster; and V = Vulnerability or resilience or the inverse of vulnerable that depend on factors such as politic, socio-economy, and environment. Vulnerable refers to inability to overcome whilst resilience refers to the ability to overcome the community affected.

Environment that can be at risk are ecosystem, habitat, population and community, biological and physical processes, energy flow, diversity, genetic, ecology resilience and redundancy. All these environment elements can be alerted either by natural disaster or anthropogenic disturbance (Kaly *et al* 2002; Gowrie, 2003).

It is being realized that vulnerability index is an important tools for researcher, ecology specialist, environmental agencies, and civil government which try to describe environmental status and tried to compare it with standardized that has been established previously. This index can works in examining part of the environments being monitored and this can help in the management of environment and natural resources efficiently. Apart from that, like other management tools, this index has a limitation as well and this is attributable to dynamic of environment. This index therefore should be checked periodically to ensure accuracy of this index (Gowrie, 2003).

As previously stated, the small islands have some inheritance limitations, for that reason the Experties in various sciences background *i.e.* economy, technology, ecology try to establish vulnerability index. There was disagreement in establishment of that index. Some put more attention on human system vulnerability towards the risk with less attention on environmental vulnerability itself. Expertise tried to overcome this disagreement by broadening the index that covers environmental, economic, social, technique, climate change, and disaster vulnerability index. Through scrutinize study, scientists were then develop qualitative parameter that describe relatively vulnerability level of one area/island include SIDS (Briguglio 1995; 2003a; 2003b; Gowrie, 2003).

Theoretically there are three aspects that can be identified easily whenever we discuss about vulnerability explicitly: *first*, risk of disaster when it come to happen; this is depend on frequency, magnitude, and intensity of the particular disaster. *second*, intrinsic resilience define as inverse of vulnerable – inheritance

characteristic of a nation that make this nation capable or less capable in managing anthropogenic or natural disaster. *Third*, extrinsic resilience towards disasters – external power that happens against the environmental and describes ecology integrity or ecosystem degradation level. This means the more damage the ecosystem of one area (as a result of natural or anthropogenic disturbance in previous time), make that area seemingly to be more vulnerable towards forthcoming disaster or disturbance.

The calculation of the EVI is based on 47 (*note*; Gowrie, 2003; Kaly *et al.*, 2003, uses 54 indices instead of 47 indices) indicators of environmental vulnerability, which have been selected by global scientific and expert review. This list includes 27 indicators of risk (REI), seven indicators of intrinsic resilience (IRI), and 13 indicators of environmental integrity or degradation (EDI). The indicators are also divided into five subcategories: six categories for meteorological events; three indicators for geological events; seven indicators for country characteristics, which are identical to the IRI; eight indicators for biological factors; and 23 indicators for anthropogenic factors. The indices are rated on a scale of 1–7 (where 1 – absent; 2 – very rare; 3 – rare; 4 – average frequency; 5 – moderately higher than average frequency; 6 – markedly higher than average frequency; and 7 – highest possible frequency) with 7 being the most vulnerable and 1 being the least (Pratt and Mitchel, 2003, Briguglio, 2003; Alder *et al.*, 2003; SOPAC, 2004). The overall environmental vulnerability index quickly identifies whether the environment of a country is highly vulnerable or not. The overall index is classified into five categories specifically: i) extremely vulnerable (365+); ii) highly vulnerable (315+); iii) vulnerable (265+); iv) at risk (215+); and v) resilient (< 215).

Environmental vulnerability index (EVI)

Among all the vulnerability indices, environmental vulnerability index was the first vulnerability index developed. Environmental problems are likely to be particularly intense in small islands and SIDS in particular due to a number of factors, some due to natural forces, others brought about as a result of economic development. In many islands, increased demand for residential housing, tourism structures and industrial buildings has given rise to a fast depletion of undeveloped land. The EVI contains three aspects of vulnerability, namely (a) natural and anthropogenic risks to the environment, with 27 sub-indices (b) intrinsic resilience with 8 sub-indices; and (c) extrinsic resilience, with 19 sub-indices. Intrinsic resilience refers the innate ability of the environment to cope with hazards (expressed as good recovery rates, high productivity or natural resistance to damage) and extrinsic resilience refers to ecosystem health (the amount of degradation of the environment as a result of past impacts determines the ability of ecosystems to cope with future stresses).

Economy vulnerability

These include the small domestic market, limited ability to exploit economies of scale; lack of natural resource endowments and high import content (especially of strategic imports such as food and fuel); limitations of diversification possibilities and market thinness; limitations on the extent to which

domestic competition policy can be applied; dependence on a narrow range of export products; inability to influence international prices; and uncertainties of supply due to remoteness and insularity. Small size also creates problems associated with public administration, the most important of which is probably the small manpower resource base from which to draw experienced and efficient administrators. Another problem is that many government functions tend to be very expensive per capita when the population is small, due to the fact that certain expenses are not divisible in proportion to the number of users.

Climate Change Vulnerability

Most of the SIDS include other small islands are found in tropic and sub-tropic area, surrounded by seawater that physically affected their environment. Socio-economic infrastructure of SIDS in particular are highly influenced by seawater and most of their economy is highly depend on tourism, marine in particular. Economy vulnerability and environment vulnerability limit the capacity of SIDS and small islands to overcome and to adapt to climate change and sea level rise.

The IPCC Third Assessment Report on Impacts, Adaptation and Vulnerability to Climate Change (IPCC, 2001: Chapter 17) concluded that “given their high vulnerability and low adaptive capacity to climate change, communities in small island states have legitimate concerns about their future. The Report identified the following key issues among the priority concerns of small island states: equity issues, i) sea level rise; ii) beaches and coastal change; iii) biological systems. (coral reefs, mangroves, and sea-grass beds); iv) human health, settlement and infrastructure and tourism; v) biodiversity; vi) water resources, agriculture and fisheries; and vii) socio-cultural and traditional assets.

Social vulnerability

Springer *et al* (2002) defines social vulnerability in terms of the extent to which the social structure of a community or a society is exposed to shock or stress brought about by economic strife, environmental changes, government policies or internal events and forces resulting from a combination of factors. St Bernard (2002) also focuses on factors generated internally, relating to education, health, resources allocation and communications. ECLAC (2000a) highlights the increased precariousness of the job market as a major source of social vulnerability, jobs offering, insecure income, no contract and no social security. Other causes include, changes in traditional social organization, problems of social cohesion exist due to ethnic or religious affiliation, which sometimes give rise to social conflicts, which in turn impact negatively on productivity and on sustainable development in general.

Trade vulnerability

This vulnerability index is more to have an effect on small island developing states since SIDS tend to be heavily dependent on international trade. Several of them are facing major difficulties in their negotiations of accession to the WTO, both in terms of financial costs and liberalization commitments. SIDS also tend to be heavily dependent on trade taxes and on trade preferences, so that adherence to the WTO rules is likely to create a higher degree of difficulty for these states

when compared to larger ones. The adoption of the WTO rules regarding subsidies are also likely to hit small states harder than larger ones, due to the fact that many SIDS rely on subsidies to counterbalance the relatively high per unit costs of manufacturing (mostly due to the problem of non-proportional divisibility of overhead costs and inability to reap the advantages of economies of scale).

Disaster vulnerability

Although natural disasters (volcano eruption, typhoon, cyclone, tsunami) occur all types of countries, the impact of a natural disaster on an island economy is expected to be relatively larger in terms of damage per unit of area and costs per capita, due to the small size of the country's territory and relatively high population density. Things that should be consider in assessing disaster vulnerability on small islands (state) are the extent of: i) how a country has established disaster preparedness and management institutions and policies; ii) the extent to which a country has developed early warning systems and facilities for the rapid dissemination of information and warnings; iii) the extent to which local broadcasting can be accessed to assist remote rural and outer island communities; iv) the degree of funding (including insurance) for communities hit with natural disasters; and v) the degree to which natural and environmental disaster policies are integrated into national

SUSTAINABILITY DEVELOPMENT AND VULNERABILITY OF SMALL ISLANDS - MALUKU CASE

Geographically, Maluku and North Maluku Province are a region that consist of more than 12 thousand islands, majority are small in their size, some medium and few of big islands with approximately 82% uninhabited. All these islands encircled by sea water (approximately 93%) and the remaining is a terrestrial area, consequently most of natural resources come from marine environment and that environment become an important aspect to these provinces. Moreover, as a consequence of being a small islands group, all the inherent characteristics of small island make these islands more vulnerable compared to big island in term of economy development, social issues, trade, climate change and environmental.

The maintenance of ecosystem or ecological integrity is at the heart of the development of a vulnerability index for the environment, because it is threatened by natural and anthropogenic hazards which in turn will have an affects the welfare of humans. The notion of ecosystem integrity is complex and cannot be expressed through a single indicator, but rather requires a set of 'smart' indicators at different spatial and temporal scales and hierarchical levels relating to ecosystems (Kaly, 2000; Kaly *et al* 1003). Sustainability development of small island in particular should be look at the wide spectrum combining not only environmental factor but also, socio-cultural, economy, legal aspect, ethic, and technique.

Comprising of many small islands makes the management of natural resources and environmental condition in relation to development in Maluku Province should become main concern. According to Agenda 21, Chapter 17 in

particular, stresses the need for sustainable development towards small islands (UNSD, 1992). One of the tools that can help decision makers and other institutes interested in the development of one area is the simple and quite accurate index that can describe the condition of one area in term of its environmental integrity. One of such index being used currently in many Small Island Developing States (SIDS) are vulnerability index that describe the integrity of that island in term of environmental, economical, climate change, social.

In some parts of SIDS in the Pacific region, vulnerability index has been employed in the management of their environmental and natural resources. Tobago, Fiji, Mauritius is an example of some countries in the Pacific region that use the vulnerability index (Kaly *et al* 2002; Howorth, 2002; Gowrie, 2003). Even this index of vulnerability is mainly developed for SIDS but can be applied for other small islands as well. In Maluku case, this index can also be developed as an indicator of ecosystem integrity the island. Some of limitations faced by Maluku in general are as follows: i) base availability and accurately; ii) intrinsic resilience in responding to disturbance; iii) genuineness commitment form decision maker.

The accuracy of one indicator in describing one object or phenomenon is crucial, therefore when defining such indicator things that required in building this indicator should be strictly examine. One thing that should be considered is data availability and its accuracy. In building vulnerability indices, one should have time series data that can be used to describe the trend related to that particular index. In Maluku case and in Indonesia in general, such type of data is very often questionable. We can have one data from different sources with different value and this is not good enough for building an indicator.

Intrinsic resilience is defined as the ability to overcome the impact experienced by affected people. One aspect in vulnerability index used is intrinsic resilience that will describe level of vulnerable of one area. Many examples have shown that we are not quick and responsible enough in this resilience aspect. If this aspect is combined with insularity of small islands in Maluku, this will even bring vulnerability of particular island is even greater.

In sustainability development of small islands, precautionary principle in the management of environmental and natural resources is an important aspect. Vulnerability indices can play significant role as a warning indicator of one particular island(s) before the development take place. By knowing these vulnerability indices in advance, one can take a precautionous prior the development, management plan or strategy can be set up hence the sustainability development can be easily implemented.

CONCLUSION

Vulnerability indices for small islands are quite useful indices that can be used as tools in describing island ecosystem integrity. These indices can be applied as precautionous principle in relation to sustainability development of small islands. Given the inherent characteristics of small island, geomorphology, geographical distribution of small islands in Maluku, risk, intrinsic and extrinsic resilience towards disaster, then the development of vulnerability indices is an avoidable requirement with some consideration on data base availability and accuracy.

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