Policy Analysis Module

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Targets

After successfully studying this module, you are able to identify and carry out all steps of a simple policy analysis given a new problem. More specific, regarding simple projects, you will know how to define a problem, establish evaluation criteria and identify, evaluate and rank alternatives. It is noted that managing a real world policy analysis requires thoroughly training and schooling in management science and is beyond the scope of the present training.

Introducing Policy Analysis

In February 1953, a NW gale swept the North Sea and, combined with the astronomical high tide, a disaster occurred in the southwest part of the Netherlands. Much of the Rhine-Meuse-Schelde region of the Netherlands was flooded inundating 130,000 hectares and killing 1835 people and urging the evacuation of 300,000.
The disaster led to the formulation of the Dutch "Deltaplan" (DELTA62), which consisted of strengthening of coast and river dikes and the construction of dams closing-off estuaries. In the mid-1970s, the protective construction were nearly complete, except for the dam in the Oosterschelde. Originally, it was decided to simply close-off the estuary, but opposition grew as people realised that the dam would destroy the rare ecology and oyster and mussel fishing industry. Thus, alternatives had to be sought. As the choice between several alternatives was complex due to the many stakeholders and interests involved, the Dutch government initiated a Policy Analysis of the Oosterschelde to analyze the alternative solutions to the problem (GOEL77).

This case illustrates when Policy Analysis is used. It can be defined as: a systematic investigation of complex policy alternatives as to assist decision-makers in choosing a preferred course of action in the public sector under uncertain conditions.

Policy Analysis is advantageous when social issues are involved, there are many contradictory interests and many non-comparable values must be compared.

Policy analysis consists of the following steps:

- problem analysis
- establishing criteria
- identifying alternatives
- evaluating alternatives
- ranking alternatives

These activities can be implemented following a linear or a concentric approach. In the linear approach, the steps are done subsequently. In the concentric approach, the activities of the study are carried out parallel. This approach aims to get insight in the problem, its alternatives and their effects, after which a further specification is formulated.

In reality, a policy study is somewhere in between these two extremes. The starting point is the linear approach, but the remaining part of the process is usually not followed from the beginning to the end "according to the book". Mostly there are one or more iteration loops. For example, it can become apparent that during the generating of alternatives, more problems become important than was initially anticipated, or more alternatives are possible than foreseen in the beginning. Another aspect is that several phases may be split-up in various sub-phases.

The five steps are subsequently discussed in this module.
Problem Analysis

In the simplest case, a coastal stretch does not fulfill its requirements and people (the government, interest groups) want certain functions to be improved. It becomes more complicated when a coastal stretch does fulfill its requirements, but that it is anticipated that within a few years it will not. When will that be, and when should measures be taken, and which measures are viable? It becomes even more complicated, when a single party has a problem (for instance a project developer) whereas all other parties judge the situation as being acceptable.

The policy maker is not only confronted with problems or wishes, but sometimes also with preferred directions of solutions. He then can follow two approaches:

- The solution-oriented approach. This approach is characterized by the implicit decision to start a project. Studies focus on the possible effects and costs of the proposed intervention, and result in a view on the feasibility of alternatives.
- The problem-oriented approach. This approach first analyses the underlying problem then studies the possible solutions.

The solution-oriented approach does not include an analysis of the problem for which

Exercise

Indicate whether the solutions to the following problems need a thorough planning using policy analysis or not:

The optimal length of a groin must be determined.
A nature conservation group has blocked the outflow of a sewarage from which polluted water flows into the sea, though the company has made clear and legal agreements with the state concerning their waste water. During a planning procedure which was fair and thorough, studies showed that the waste water will not harm the environment.
A commercial harbour wants a deeper access channel crossing an estuary. However, rare bird species live on the adjacent intertidal flats and many people depend on the fish living in the estuary as a primary source of food.

The steps in problem analysis can be done simultaneously to improve the speed of decision making

- true
- false
the solution is meant. Consequently, one runs the risk that at the end, the 'best' alternative does not solve the problem. Quite often it occurs that during the policy making process, the question arises to which problem the proposed solutions actually refer. Then the underlying problem is analysed, which actually means that a shift occurs in the orientation of the research: from solution-oriented towards problem-oriented approach.

A problem analysis following the problem-oriented approach consists of problem orientation, problem delimitation and problem definition.

**Problem orientation**

The problem orientation gives an idea about the policy problem that needs to be solved. In order to identify viable alternatives, a concrete formulation of the problem is required. For this, a thorough analysis is needed, which should include:

- the causes of the problem;
- the historic background;
- who put the problem on the agenda;
- what are the interests at stake (user functions);
- who are involved in the decision-making;
- which aspects are relevant;
- what are possible (directions of) solutions.

An inventory of the 'agenda setting' gives an impression of possible political pressure. Also insight is obtained in the room for initiative that is available: the boundary conditions of the policy.

**Problem delimitation**

In the delimitation of a coastal zone management problem, it is important to identify the boundaries of the coastal zone itself and to identify the stakeholders in that zone. These identifications very much depend on the character of the problem itself.

When the problem refers to an eroding coastline, the problem formulation is relatively easy:

- the physical boundaries of the coastal zone follow from a coastal morphology analysis (the eroding coastline itself and its neighbouring stretches);
- the stakeholders are those whose possessions are in danger when no measures are taken, plus those responsible for the coastline.

**Exercise**

Describe and delimit as much as possible, five problems currently under discussion in your own country. Use about 200 words on each.

[send to tutor]
Establishing Criteria

When the problems refer to the quality of the coastal waters, then both the identification of the coastal zone and the stakeholders can be much more complex:

- where to make the boundaries of the coastal zone?
- who are the involved parties?
- who is responsible?

To come to a useful problem definition it is necessary that all parties involved (representing all relevant functions) are identified, and that they come to an agreement on the goals of the project and on the standards to be reached. With the use of these goals and standards the desired end-situation after completion of the project can be described in objective units. Then it becomes possible to test the expected effect of a project to the goals and standards.

**Problem definition**

The definition of the policy problem can be defined as a detailed and operational description of the difference between the existing situation and the desired situation. This description should be made as concrete and detailed as possible, as to allow for a good referencing. When a quantitative description is not (fully) possible, the differences should be expressed qualitatively.

The most favourable approach is to describe the zero-situation and the desired situation separately.

The zero-situation is the current situation in the coastal zone plus its development when no further policies/projects are implemented. For the description of the zero-situation, two subsequent activities need to be carried out:

1. Description of the existing situation for all user functions. This (quantitative) description serves as reference for the changes that will occur as a result of the new policy;
2. Description of the autonomous developments of the coastal zone without the new policy

The desired and zero situation should as much as possible be described in coherence, as to allow for a sound comparison. Therefore it is required that the often vague and abstract formulated wishes are translated into concrete terms. For instance, the wish 'healthy coastal ecosystem' could be specified in number of different species, concentration of pollutants and the turbidity of the water.

**Exercise**

Consider the problem of oil and gas exploration from under a large intertidal wetland. Imagine that the government needs the oil and gas as it is a major source of income for the state, but local people fear the decline of nature in such an international important nature reserve. Decline in nature might...
The problem analysis. Both the activities in the orientation phase and in the definition of the policy problem give an indication for the determination of the evaluation criteria. In the orientation phase, it was already investigated which aspects are relevant. An analysis of wishes, friction points, complaints or initiatives around the subject under study can give an indication of relevant evaluation criteria. A further definition of those relevant aspects was made during the description of the zero-situation and the desired situation. In almost all cases it was needed to determine the units that identify these aspects. So, already some evaluation criteria were formulated during the definition of the policy problem;

- the character of the alternatives. This set refers firstly to technical and institutional aspects that may have a role during implementation. Further aspects may be aesthetically of character (like landscape considerations). It should be noted that the criteria of this group are generally qualitative;
- analogue problem situations. Evaluation criteria from already implemented projects or policies around a similar problem may serve as inspiration;
- check lists (systematic listing of points of attention) can also be starting point for the determination of evaluation criteria. Check lists are general in nature: they should not limit the creativity of those who are responsible for determining evaluation criteria, but should only be used in addition. ADB Environment Paper (1991) shows an example of checklists that can be used in Coastal Zone Management.

The central government can be a good source for evaluation criteria at macro level. Such parameters relate to the objectives concerning employment, (development of ) income, inflation levels. But, e.g., also objectives of physical planning, environmental management, the availability of resources and technological development should be used to come to evaluation criteria.

Read a list of important criteria.

Occur due to the bottom subsidence (and flooding) which will occur in the area according to some geologists.

a) Consider the following criteria and decide whether they are proper to base a decision upon regarding the exploration:

- The extent to which nature is affected.
- The change in area of mussel banks.
- The total subsidence in the area.
- The amount of money earned from the project, relative to the total income of the state.

b) Give five other criteria yourselves.

Exercise

Of the problems you described in the previous section (Problem analysis), now give 10 criteria each to judge alternative solutions on.

Feasibility. Distinction can be made between technical and political/social feasibility:

- technical feasibility: it seems straightforward that alternatives should be technical feasible. When the implementation of certain alternatives requires the development of new techniques and/or technology, than the level of uncertainty of a successful realization of such alternative is rather high. However, the conclusion that such alternative is not feasible need not be automatically drawn. Under special circumstances, the decision-makers may opt for such alternative (for instance the Eastern Scheldt Storm Surge Barrier in The Netherlands, where new techniques and technology needed to be developed for implementation of the most promising alternative);
- political/social feasibility. Political feasibility refers to the a priori acceptance of an alternative within the administrative bodies. It is, however, not easy to estimate...
Identifying Alternatives

An alternative can be defined as a project or a (complex) of policy measures with which the gap between the desired situation and the zero-situation can be (fully or partly) be closed. In other words, it is (a combination of) measures which solve the earlier defined problem sufficiently.

Two sub steps can be identified; generation and pre-selection. In addition, the alternatives are restricted by a set of boundary conditions.

Generation of alternatives

In general, the generation of alternatives is not a controlled process. Possible solutions come already on the surface during the problem analysis. It can even be the case that the proposal of a certain alternative forms the start of a policy analysis.

In most cases, the initiator of the policy analysis will come up with alternatives. In addition, alternatives can be proposed by individuals or groups that are not directly involved in the study (like pressure groups). The initiator can also demand that certain alternatives are not included in the study.

In certain studies, both the number and the content of alternatives can be determined on forehand. In these cases, it is needed to know the background of these decisions (like time limit: a decision is needed in short term). It can also be the case that the study initiator likes to prevent that incorporation of new alternatives will lead to the situation that 'his' alternative comes in danger. A further analysis of the alternatives of the study initiator can reveal the implicit boundary conditions of the policy study (like financial restrictions).

Exercise
In other cases, the analyst has the freedom to determine both number and content of the alternatives within given boundaries himself.

See the list with points of attention for the generation of alternatives.

Pre-selection of alternatives

It is very well possible that in this phase of the project study, there are a large number of alternatives, even a too big number of alternatives. It is impractical and very costly to work out all these alternatives at sufficient detail, to present them and to include them in the final decision making process. A further reason to limit the number of alternatives might be the evaluation method that will be applied, as some methods can handle only a limited number.

In those cases it is necessary to make a pre-selection. The large number of alternatives is reduced to a limited number of promising solutions. A first reduction can already be obtained through clustering: alternatives with a certain similarity are clustered and considered as one alternative. In a later stage, such clusters can be split up into variants, which feasibility can be further analysed.

It might be needed that during pre-selection, a global inventory is made of possible effects.

Are these statements correct?

- Choosing the zero-alternative means, by definition, that there will be no policy
- Describing "a scenario" and "an alternative" are identical assignments
- When establishing alternatives, criteria of feasibility, robustness and flexibility already come into the picture to evaluate whether the alternative is realistic or not

Boundary conditions

Practice shows that the generation of a number alternatives is largely restricted by given boundary conditions. Different categories of boundary conditions can be identified, which may follow from:

Exercise

Use the problems you described before. Describe three alternatives for each problem. Use about 200 words on each.
1. earlier defined objectives. Possible alternatives can be in disagreement with already implemented policies or projects, or with defined time limits. Alternatives that implicate a drastic change in policy may lead to a reduction of the results of the former policy/measures or that they lead to unacceptable costs;
2. policy of higher governmental bodies. This especially refers to the limit of policy freedom of lower government levels (municipalities, water boards, provinces) by a central government;
3. organizations at the same level. This refers to the interface of different municipalities or different countries. Difficult achieved inter-departmental compromises may thus lead to narrow boundary conditions;
4. political and socio-economic environments. The expected political feasibility can form an important boundary condition. A politician likes to be re-elected and therefore like to take decisions that his/her voters like;
5. available means. This is the most common group of boundary conditions. This is not only referring to finances, but also to the availability of (specialized) staff, natural resources, availability of information and/or know how.

Boundary conditions 2, 3 and 4 originate from outside the organization that commissioned the study.

It should be realized that boundary conditions may change (for instance under influence of outside pressure, or by the study initiator). Therefore, the identified boundary conditions should not be interpreted in a too narrow manner. A good communication with the study initiator is strongly advised.

**Points of attention for the generation of alternatives**

- **the zero-alternative.** Don’t forget this “business-as-usual” scenario. Even when it is not a serious option, it still provides the base for comparison of the other alternatives
- **regular versus unique problems.**
  - 'regular' refers to similar (almost identical) policy problems. Use can be made of experience in similar cases, where alternatives were developed for similar problems (analogue alternatives). Here, it is less urgent to develop additional, new alternatives as long as there are no signs that the 'traditional' alternatives give friction;
  - for 'unique' problems, sometimes reference can be made with somewhat analogue problem situations: alternatives that were developed for a problem in a total different field of expertise.
- **the generation of variants on alternatives.** Already formulated alternatives can be the starting point of new alternatives. For instance, elaborated alternatives can be modified by changing those aspects that are responsible for a poor performance of that alternative (this especially refers to negative side effects). In this way, alternatives can be improved (reducing costs, different financing structure, different phasing in implementation). These alternatives are identified on the basis of a global inventory of the effects of the original alternatives;
- **system description.** The system-analytical description used for the zero-situation (and/or for the desired situation) reveals the possibilities and means of influencing the system. Based upon this knowledge, alternatives can be generated.
- **scenarios.** Scenarios are used to specify uncertain exogenous developments, which have an impact on the project, but which are not determined by them. Coastal zone management scenarios are commonly based on expected developments of, e.g. the climate and the associated sea level rise;
- **phasing in time.** When already identified alternatives do not give an adequate solution for the policy problem, it can be investigated to which extent a combination of different types of (mutual supporting) alternatives in time offer an alternative itself.

**Evaluating Alternatives**
Kinds of effects

An effect can be described as a change in the existing situation that result from an action. Effects of alternatives are determined by taking the difference between the realization of an alternative and the reference situation. Commonly, the zero-situation is taken as reference. Effects can be grouped as follows:

- aimed and side effects;
- direct and indirect effects.

Effect forecasting

Experience plays an important role with the prediction of effects. Based upon experience, relationships between effects can be determined. With the prediction of effects of alternatives, it is needed that these relationships can be made explicit and that can be indicated to which extent a certain change in one effects influences the other. This can both be quantitative and qualitative. (further reading)

Cost of an alternative

To implement an alternative, manpower, money and natural resources are needed. These could also be used for other activities. In other words, another activity can (partly) not be implemented to realize the project under consideration. In fact, the benefits related to such other activity are to be included in the evaluation as cost for the current project. These are so-called opportunity costs or alternative costs. (further reading)

Monetary methods

Monetary methods aim at providing a quantitative overview of all positive and negative effects of alternatives. These effects are expressed as much as possible in monetary terms: costs and benefits. In Coastal Zone Management projects, such monetary methods are used to indicate the socio-economic effects: they include positive and negative effects of those who are not directly involved in the project. Thus, alternatives are ranked on the basis of their socio-economic rentability. Common used selection/decision criteria of monetary methods are: Benefit-Cost (B/C) ratio and the Internal Rate of Return (IRR). (further reading)

Exercise

Are the following statements correct or not:

Correct Incorrect

- To prevent dune erosion, the beach is nourished. The beach becomes broader and attracts more tourists; this is a side-effect.
- When studying coastal protection measures, to apply beach nourishments is an alternative. Sand can be used that is being dredged from a nearby access channel. The dredging costs don't have to be taken into account in the analyse as they are sunk-costs.
- A government chooses to use a dune area for water treatment plants. The area is also very suitable for recreation, but there is no access road. The land is already public property, so, the total costs of the development will only be 100,000 dollar to build the plant and connect it to the existing water service pipes.

Exercise 10

Previously, you described five problems and gave ten criteria and three alternatives per problem. Now choose one or two problems. Describe the effects of each alternative with respect to the criteria you chose. Be as quantitative as possible. Depending on your time available you can either guess certain values, make use of models or ask the opinion of experts. Use about one page (A4) per alternative.

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Aimed and side effects
Aimed effects are intended to result from an implemented policy. Side effects are those that also occur due to implementation, but were not aimed at. These effects might be both positive or negative. For example, if a beach nourishment is one of the alternatives for combating chronic erosion (= aimed effect), a wider beach will be the result (= side effect). This is a positive development for the beach recreation (a positive side-effect). However, also more sand will be blown inland in the agricultural area behind the coast (a negative side-effect).

Very often, side effects are in areas of interest which are not in the direct field of the agency or ministry responsible for the project. But mostly civil servants of this ministry determine whether these side-effects are to be included in the study or not. It is clear that this can not be done without consultation of the parties involved (like farmers, fisher men and nature conservancy agencies).

Direct and indirect effects
Direct effects materialize immediately upon implementation of an alternative. Indirect effects result from the direct effects. "Direct-Indirect” does not give information on their importance; a direct effect needs not to be of higher value than an indirect one. There is also no relation with the aimed and side effects. Indirect effects can be both positive (like more employment inside and/or outside the study area) and negative (like more pollution, disturbances in the food chain).

Effect forecasting
The first step with effect forecasting consists of an inventory of the direct effects of an alternative followed by the inventory of the indirect effects. For the latter, for each direct effect a list is made of its indirect effects and its relationships with them.

In first instance, these direct and indirect effects will be described qualitatively. It is however strongly advised to make them quantitative as early as possible:

- quantification of direct effects can be based upon experience with similar alternative or historic information. When these are not available, experiments (like scale models) and system models (e.g., economic models and ecological models) might be helpful;
- quantification of indirect effects is usually based on historic data. Experiments are most commonly not suitable, given its restricted scale and/or time horizon.

As said before, system models might be helpful for the quantification of direct effects, as it describes the character of a (part of a) system. The value of such a model for effect forecasting depends amongst other on the level of aggregation. When this level is high (many components of the system are clustered), then the value of the outcomes of the model is relatively low. In other words, the model to be used to describe a system should be at the same level as the project under study.

Cost of an alternative
In practice it is rather difficult, if not impossible, to find another project that could be used for determining these opportunity costs. Therefore, the value is estimated of those resources that will be applied with the current project.

For the judgement of alternatives, only those resources are relevant that can be utilized in an alternative way. Costs for which this is not possible (so-called sunk costs) can not be taken into account.

In principle, the costs should be considered over the lifetime of an alternative. This refers to both the investment costs (done in the initial years of the project) and the exploitation and maintenance costs (yearly costs). For this it is needed to take changes in price levels and inflation into account. And these are subject to a large range of uncertainty. Therefore, these cost calculations are based on constant prices at a fixed moment (normally those of the year in which the study is carried out). Relative changes, however, should be included.
It is possible to determine for each alternative the total costs in an integral way, resulting in the real costs that are needed for project realisation. However, such totals are rather difficult to interpret, especially when complex alternatives are investigated. This is also valid when effects need to be compared. Simply adding up all costs or the average costs per year does not give any information on the time in future that these costs will be made.

A common way to avoid this problem is discounting, with which the present worth of a future amount of costs (or benefits) can be obtained. Discounting results in determining money flows of certain years in future to a certain base year. For this, use is made of a discounting factor, which is expressed as:

\[
df = \frac{1}{(1+p)^n}
\]

where:
- \( df \) = discounting factor;
- \( p \) = discount rate (in %);
- \( n \) = year in which the costs are made in relation to the base year.

For example, the discount factor for costs that occur in year 3 are (for a discount rate of 5%):

\[
df = \frac{1}{(1+0.05)^3} = 0.8638
\]

So, US$ 100,000 to be spent in year 3 correspond to a discount value of US$ 88,380 in the base year.

A crucial point is which discount rate should be used. This very much depends on the project initiator. For the Dutch Government, the discount rate for governmental projects is set at 5%. This percentage includes the difference between interest and inflation. Such percentage is also valid for countries with high inflation rates, as then also interest rates will be high. This percentage is uniform and is 'without risk':

- uniform means that this percentage may not vary for differences in lifetime of projects or for relative changes in price and worth levels;
- without risk means that it does not include the risks that belong to the implementation of alternatives (like higher implementation costs, disappointing benefits).

In addition, it was decided that projects can only be implemented when the government budget allows for it.

It should be noted that the way of financing an alternative may result in certain effects. For the determination of these type of effects, insight is needed in the costs. In contradiction with the practice in the private sector, the Dutch government does not make a direct link between ways of financing and its desirability. So, interest costs are left out of consideration. Consequently, there is only an indirect link when financing of alternatives is being judged.

**Monetary methods**

The B/C is the ratio of the present worth of benefits and costs (discounted for the same discount/interest rate). Alternatives which have a B/C ratio larger than 1 are considered as profitable.

The IRR, is the discount rate at which discounted benefits equal discounted costs. Decision on profitability is based on a comparison of the IRR with a minimum interest rate (a political choice).
Costs and benefits of alternatives are compared with the reference situation (in most cases the zero-situation). To value these in money, economic prediction models can be used. It is, however, difficult to estimate the benefits satisfactorily. Some benefits can not be expressed in money and will be described qualitatively. The values of such benefits are indicated in the effect overview as PM. In such cases, the effect overview does not give a full indication of the effects, so that an unequivocal ranking of alternatives can not be obtained.

A special monetary method is a cost-effectiveness analysis, which can be used of identifying the alternative that:

- is most efficient (minimum costs), given the aimed effects;
- has maximum effects, given the means.

A cost-effectiveness analysis can not be used for indicating the rentability of alternatives; only for ranking.

In translating non-monetary values of for instance nature reserves, sometimes use is made of replacement values. Here, questions need to be answered like: "How much is the willingness to pay (from society) for maintaining the nature reserve or creating a new one".

### Ranking Alternatives

With ranking is meant; displaying the alternatives in such way that decision makers can judge the effects of each and choose between them. In coastal zones, several disciplines are usually involved in a project and each have their own criteria to judge alternative solutions by. The analyst must therefore cope with multiple (sometimes conflicting) criteria when ranking the alternatives. Two large groups of methods can be distinguished:

- aggregated methods, where the scores of alternatives on the various criteria are lumped and a final ranking of alternatives is obtained, and
- disaggregated methods, where the result per criterion per alternative is presented in a tabular form.

Though aggregated methods can be useful for initial quick analysis and for groups with similar interest to choose a preferred solution. Due to their limitations, in public sector problems the disaggregated methods are preferred.

### Exercise

How suitable are aggregated methods to rank alternative solutions in the case of the development of a port terminal in an urbanized area, considering the client (decision maker) is the major?

In the previous tutor exercise, you defined two problems and associated criteria and alternatives with them. Now make a Goeller scorecard of the alternatives of both problems.

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methods that process quantitative information:
- **weighted summation method**, in which the (standardized) parameter scores are multiplied with the corresponding parameter weights. For each alternatives, the resulting values are added. By comparing these sums a ranking of alternatives can be obtained;
- **Goals-achievement matrix**, which presents for each alternative the changes that will occur in relation to the (explicitly formulated) project goals. A break down can be made into the different societal groups that would be affected by the implementation of the alternatives. The relative weight of the different goals and groups can be included too. For ranking the alternatives, a further processing of the matrix is required in most cases;
- **Concordance analysis**, in which the alternatives are compared two by two. The first step is to determine, on the basis of parameter scores and weights, which of the two alternatives is to be preferred. This is done without looking to the magnitude of differences between the scores and weights. The second step is to analyse in which extent the alternatives are dominated by the other. This analysis is based on the magnitude of differences between the (standardized) scores and the weights. For each pair of alternatives, the outcome of these analyses is presented by indices. The amount of alternatives can be reduced by comparing the indices to threshold values. A further mathematical processing of indices is required to come to a ranking;
- **Permutation method**, which confronts the ranking of alternatives per parameter with all possible rankings;

methods which process qualitative information:
- **Regime method**, in which alternatives are two-by-two compared. For each judgement parameter, it is determined which of the two alternatives scores better (score +1, and worse (score -1). The outcome of all possible comparisons are displayed in a regime matrix. To determine an overall ranking of to alternatives, the values in the regime matrix are multiplied with the judgement parameter weights and added, as to come to an overall ranking.

mixed methods:
- **Evamix method**. As a first step the quantitative and qualitative information is dealt with separately through two separate overviews. Alternatives are compared two-by-two for each overview. The outcome is displayed in two dominance matrices, which display the respective dominance scores, thereby indicating to which extent one alternative is dominant over the other. Through standardization of these two matrices, a mutual comparison of quantitative and qualitative information becomes possible. Summation of the standardized dominance scores, including the weights of the quantitative and qualitative judgement parameters results in a total score of each pair of alternatives. These scores can be used to come to an overall ranking of alternatives.

**Limitations**

- **loss of information.** For example, aggregation suppresses the fact that alternative A has environmental effects, whereas alternative B has financial effects;
- **subjective weighting of different aspects.** Unfortunately, these crucial weights and assumptions are often implicit or highly speculative. They may impose to the decision makers a value scheme bearing little relation to their concerns. For example, cost-benefit analysis implicitly assumes that a dollar's worth of one kind of benefit has the same value as a dollar's worth of another. Yet in many public decisions, monetary equivalent but otherwise dissimilar benefits would be valued differently by society.
- **impossibility to aggregate for several clients with different points of view.** The aggregate techniques are intended to help an individual decision maker in selecting the preferred alternative, the one that best reflects his values (importance weights). Serious theoretical and practical problems arise when there are multiple decision makers: Whose values should be used (the issue of inter-personal comparison of values), and what relative weight does the group give to the preferences of different individuals (the issue of equity)?
- **assumption of independence effects.** The aggregate technique (others than cost-benefit analysis) requires that the importance (value) of each effect be independent of the size of all other effects. But in the real world, this condition is not always satisfied. Each effect that violates this condition must be suppressed, either by eliminating it or by treating is at the next level of aggregation.

**Disaggregate methods**
A common used disaggregate method is the Goeller scorecard. It results in a column of effects for each alternative, with each effect being expressed in its 'natural' units. In comparing the alternatives, the decision-maker can assign whatever weight he/she deems appropriate to each effect. Explicit consideration of weighting thus becomes a central item to the decision process itself, as it should be.

Prior analysis can consider the full range of possible effects, using the most natural description for each effect. Sometimes effects can be described in monetary terms and others in physical units; some are assigned with quantitative estimates (e.g. "100 jobs would be created"), others with qualitative comparisons (e.g. "recreation opportunities would increase slightly"), and still others with statements of non-ordinal facts ("an attractive tourist site would be destroyed"). A disadvantage of this approach is that the amount of detail makes it difficult for the decision-maker to identify patterns or to come to conclusions.

Effect values are summarized (in natural units) in a table, each row representing one effect and each column representing an alternative. Colours can be added to indicate each alternative ranking for a particular effect, for example Blue for the best value, Yellow for the worst and Grey for the intermediate values.

As an example, the summary score-card of the Eastern Scheldt project is given. The three alternatives mentioned are:

- **Closed case**: closing the Eastern Scheldt estuary with a dam;
- **SSB-case**: closing the Eastern Scheldt estuary with a storm surge barrier;
- **Open case**: not closing the Eastern Scheldt, but improving the dikes around the estuary.

### Summary score card of the Eastern Scheldt project

<table>
<thead>
<tr>
<th>Item</th>
<th>Closed case</th>
<th>SSB-case</th>
<th>Open case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction costs (DFL million)</td>
<td>2135</td>
<td>4645</td>
<td>3620</td>
</tr>
<tr>
<td>Annual maintenance (DFL million)</td>
<td>10</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Peak year expenditure (DFL million)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land flooded (ha) in 1/4000 storm</td>
<td>0</td>
<td>0</td>
<td>400</td>
</tr>
<tr>
<td>Technical uncertainty</td>
<td>None</td>
<td>Scour</td>
<td>Dikes</td>
</tr>
<tr>
<td>Land flooded during construction (ha)</td>
<td>430</td>
<td>200</td>
<td>530</td>
</tr>
<tr>
<td>Value of real estate flooded (DFL million)</td>
<td>50</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>Number of people at risk</td>
<td>800</td>
<td>360</td>
<td>970</td>
</tr>
<tr>
<td><strong>Ecology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid kill of benthic biomass (tons afdw)</td>
<td>41500</td>
<td>4500</td>
<td>4200</td>
</tr>
<tr>
<td>Gradual loss of biomass (tons afdw)</td>
<td>5000</td>
<td>-8000</td>
<td>300</td>
</tr>
<tr>
<td>Time to stabilize (years)</td>
<td>6.5</td>
<td>6.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
## Exercise Policy Analysis

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Best alternative for indicator</th>
<th>Intermediate alternative for indicator</th>
<th>Worst alternative for indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total biomass (tons afdw)</strong></td>
<td>5200</td>
<td>29700</td>
<td>21300</td>
</tr>
<tr>
<td><strong>Potential benthos-eating birds (tons afdw)</strong></td>
<td>1</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td><strong>Potential fish-eating birds (tons afdw)</strong></td>
<td>4</td>
<td>.06</td>
<td>.03</td>
</tr>
<tr>
<td><strong>Potential mussels (percent of present)</strong></td>
<td>13</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td><strong>Potential oysters (percent of present)</strong></td>
<td>0</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td><strong>Fish nursery function (percent of present)</strong></td>
<td>0</td>
<td>133</td>
<td>73</td>
</tr>
<tr>
<td><strong>Fishing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jobs lost</td>
<td>199</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Annual production loss (DFL million)</td>
<td>30.3</td>
<td>1.4</td>
<td>0</td>
</tr>
<tr>
<td>Accumulated net loss (DFL million)</td>
<td>89</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Shipping</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accumulated savings through 1999 (DFL million)</td>
<td>27.2</td>
<td>8.9</td>
<td>0</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra sea beach visits</td>
<td>338</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extra inland beach visits</td>
<td>108</td>
<td>88</td>
<td>68</td>
</tr>
<tr>
<td>Percent decrease in salt-water fish quantity</td>
<td>75</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Number of extra moorings</td>
<td>&lt;1060</td>
<td>&lt;900</td>
<td>0</td>
</tr>
<tr>
<td><strong>National economy (peak year)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jobs</td>
<td>5800</td>
<td>9000</td>
<td>5700</td>
</tr>
<tr>
<td>Imports (DFL million)</td>
<td>110</td>
<td>200</td>
<td>130</td>
</tr>
<tr>
<td>Production (DFL million)</td>
<td>580</td>
<td>940</td>
<td>560</td>
</tr>
<tr>
<td><strong>Regional effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households displaced</td>
<td>-37</td>
<td>0</td>
<td>124</td>
</tr>
<tr>
<td>Jobs, peak year</td>
<td>230</td>
<td>90</td>
<td>290</td>
</tr>
<tr>
<td>Production, peak year (DFL million)</td>
<td>-37</td>
<td>13</td>
<td>38</td>
</tr>
</tbody>
</table>
This exercise leads you step-wise through the principles of policy analysis with the help of the (fantasy) case study Pesisir Tropicana. The **general introduction** to the area, describes the problems which are faced by the people living there. There appears to be money available for investment: approximately 800 MUlc (Million Unit local currency), of which 200 MUlc could come from the World Bank.

During this exercise you will establish alternative ways to invest the money, compare and rank these using the theory presented in this module.

The exercise will take approximately two days to do. Please read the general introduction first, then follow the links to the questions.

**Questions phase 1:** Problem analysis  
**Questions phase 2:** Establishing criteria  
**Questions phase 3:** Identifying alternatives  
**Questions phase 4:** Evaluating alternatives  
**Questions phase 5:** Ranking alternatives

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**General introduction to the area**  
Pesisir Tropicana is situated in a tropical area. The region covers approximately 3,200 km² with 600,000 inhabitants. The region can be split into two areas:

- the coastal region (Pesisir Tropicana) which is described below;
- the inland region, which shows a marked similarity to many developing countries in the tropics and which will not be described in detail.
The Region offers possibilities for hydropower development, production of timber, mining, development of tourism, aquaculture and intensification of agriculture. At the moment none of these resources is exploited, apart from tin mining and small-scale timber production.

A limiting factor is the absence of good transport facilities in the inland region. During the wet season most of the roads are either flooded or otherwise impassable. Transport by boat is of local importance but due to the meandering of the river and the occurrence of rapids and sand-banks navigation is only possible in the delta region and the lower
reaches of the river.

The traditional land-use in most of the region consists of small-scale agriculture and fishing. As tourism is becoming more important economic benefits could be obtained by the establishment of protected areas. Especially the coastal region offers opportunities for development in the form of beaches and coral reefs and islands. In the region some animal and plant species occur that are rare or absent elsewhere in the country. Moreover some of the coastal and inland wetlands are important for migratory birds.

Development in the coastal region has consisted until now mainly of utilization of the mangrove forest for timber and fire wood. Locally shrimp production has started and is now rapidly expanding.

Improved irrigation would partially solve the need for more agricultural land, both for the production of cash crops for export or for food production. On a national scale the demand for energy is increasing and the hydropower potential of the region is of considerable interest. It could also be a key factor for the exploitation of the mineral resources in the region. The existing forest could be exploited both for timber and for paper production. As a result of the topography, climate and soil types in the area the risk of erosion is however considerable.

In the dry season ground water is used as the drinking water supply.

There is a large urban complex, Portharbor, with port and industrial facilities, with a well-developed service sector. Traditional fishing mainly takes place in the coastal waters. In the hinterland, various types of primary production take place, including agriculture and mining. Wage levels, existing pollution control and production technologies are comparable with those of many countries in tropical areas.

At this moment a dam in the Rio Pusing is under construction; this dam will provide energy and water to this region.

**Exercise Policy Analysis**

**Phase 1**

First [read more](#) on the problems in Pesisir Tropicana.

**Problem orientation**

Questions:
1. List possible project initiators ([Answer](#))
2. Which aspects of Pesisir Tropicana do you consider of relevance for the analysis. ([Answer](#))
3. List possible project options in broad terms. ([Answer](#))

**Problem delimitation**

Questions:
4. What are the physical boundaries of Pesisir Tropicana. ([Answer](#))
5. Which disciplines are relevant to be included in the analysis. (Answer)
6. Who are possible stakeholders: (Answer)
   - within the Region
   - outside the Region

7. Who will take the decision on investment. (Answer)

**Problem definition**

Questions:
8. Identify indicators needed for the zero-situation of Pesisir Tropicana. (Answer)
9. Describe systematically the zero-situation of PT. (Answer)
10. Describe the desired situation of PT. (Answer)

**Problems in Pesisir Tropicana**

Two rivers flow into the Bay Teluk near Portharbor: Kali Migraine and Rio Pusing. Kali Migraine carries agricultural run-off (mainly nutrients, phosphates from fertilizers) from the rice fields upstream. Also a tin mine is located upstream, which is an important industry in the region. The tin-ore (cassiterite) is dredged from the flood plain of the river. The tailings of the mine are also flushed in the Kali Migraine. Rio Pusing does contain less pollutants.

The city of Portharbor is located along the Bay Teluk, and includes industrial activities and port facilities. Here, oil from shipping, household waste from a municipal waste water treatment plant and industrial effluent enter the bay. Some traditional fishing takes place just beyond the spit Sandy Point. A 9 km stretch of undeveloped shore line lies on the eastward side of Bay Teluk, and beyond that a slightly sheltered bay, with significant coral reef communities. The clear waters and coral reefs in the Pesisir Tropicana Region are ideal for bathers and skin divers.

The area around Lilly Town is mainly in agricultural use. In the polder-island, north of Lilly Town there is intensive rice production. The island opposite Portharbor is mainly used for grazing cattle; it is rather peaty over there. The right bank of the Kali Migraine is urbanized. In the non-buildup areas there are many scattered buildings, small industry, etc. The area just east of Portharbor is mainly used for horticulture.
Physical characteristics

There is a normal tidal range of the order of 2.0 m. Tidal currents in the gullies in Bay Teluk are up to 1.7 m/s. The average discharge in the Kali Migraine is 1000 m$^3$/s, in the Rio Pusing it is 100 m$^3$/s. The average rainfall is 2800 mm per year.

Because of the high river runoff, the western part of the estuary has a very low salinity. In fact the saline water does not enter the rivers, and stays into the basin of Bay Teluk. Only during the dry period, some increase in salinity can be observed in the first 5 km of the rivers, causing some problems with the irrigation intake structures in the lower section of the river.

The water of the Kali Migraine is hardly used for irrigation of the rice-paddies around Lilly Town, because of the high contents of solids due to the mining activities. So, nearly all irrigation water comes from the Rio Pusing.

The catchment area of the Rio Pusing is rather small, in the order of 1600 km$^2$. The rainfall in this area is given in the following figure.

This results in a discharge curve of the Rio Pusing with an average discharge of 95 m$^3$/s in week 1 to 19, a discharge of 14 m$^3$/s in week 20 - 37, and a discharge of 80 m$^3$/s in week 38 - 52. The average discharge is 63 m$^3$/s. Just outside the map of the area, a dam is under construction; this dam has a head-difference of approx. 30 metres. The installed power of the hydro-turbines is 25,000 kW; however it is assumed that this dam will not be used at full power. A constant average output of 15,000 kW is expected.
During 50% of the year winds come from southerly directions, southern winds are never strong. During 30% of the year, winds come from north-westerly directions, creating a wave height of approximately 1 m. During 10% of the year (35 days), winds come from northern directions, creating a wave height of approximately 3 m. However, this occurs only during the three months of the stormy season.

The wind speed exceedances, in occurrence per year, as function of the direction is given in the Table 1:

**Table 1** Wind speed exceedances

<table>
<thead>
<tr>
<th>Direction</th>
<th>15 m/s</th>
<th>20 m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>0.03</td>
<td>0.0006</td>
</tr>
<tr>
<td>NW</td>
<td>0.04</td>
<td>0.0015</td>
</tr>
<tr>
<td>N</td>
<td>0.07</td>
<td>0.009</td>
</tr>
<tr>
<td>NE</td>
<td>0.06</td>
<td>0.005</td>
</tr>
<tr>
<td>E</td>
<td>0.02</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Sometimes tropical storms can create strong winds from easterly and north-easterly directions. The frequency of these tropical storms is relatively low, but most people remember the disastrous storm of 15 years ago, when the sea flooded most of the urban area.

The sea north of Pesisir Tropicana can be considered a relatively shallow sea, with an average depth of 10 - 20 metres over a distance of 50 km. At this point is the edge of the continental shelf, and the bottom drops to -100 m. The next shoreline is 700 km away.
Economic activities

Economic activities are in the following sectors and expressed in terms of Units of Local Currency (Ulc):

Tin mining

The tin-mining activities are located in the floodplain of Kali Migraine. The produced cassiterite is transported overland to the commercial port of Portharbor. The annual output is one million tons, representing 100 MUlc. This sector employs 15,000 people in the region. There is currently no on-site treatment of cassiterite at the mine.

Agriculture

Agriculture is mostly concentrated in the watershed of the Rio Pusing. The agricultural activities include rice cultivation and animal husbandry, mostly for local consumption. The economic value amounts 55 MUlc. There is a very limited potential for increasing the area for agricultural production. Agricultural run-off goes to the Rio Pusing, which flows into Bay Teluk.

The water of the Rio Pusing is used for irrigation in the area north of Lilly Town. This area is 512 km$^2$, but only 90% is real irrigated rice paddy (450 km$^2$). At this moment only one crop per year is produced, but after completion of the dam, double cropping will be introduced.

The water demand of this area is determined using the method worked out by Thoradeniya (1995). In the following figure the demand per week is given as function of time. Given are the periods in which the given value is needed. The total demand of water over the year is 949 mm/year, which corresponds to an average required discharge of 14 m$^3$/s.
Tourism

Portharbor has a number of hotels, mainly used by the business community and some local tourists. They contribute to the regional economy with 15 MULc annually. The residuals generated by these hotels are considered as part of the household wastes, and can not be distinguished from these.

Fisheries

Fisheries in the Pesisir Tropicana Region is mostly traditional and practised on a limited scale around the small coral reefs, bars and islands (cays), which are scattered in the entrance of Bay Teluk. Some fishermen use dynamite, which officially is forbidden. However, it can be practised, as there is a weak law-enforcement. There are no fishing activities in Bay Teluk itself. The current annual output in the fisheries sector is 10,000 tons of fish, representing 30 MULc, all of which is used for local consumption. Approximately 30,000 people are involved in fishing, using 6000 boats. Presently, aquaculture is practised on a very limited scale, and has no significant economic value.

Figure 6: Artisanal Fishery
Other sectors

The other sectors are, economically speaking, relatively small when compared to the above mentioned ones. They refer to building, general industry, retail and services, etc. The total number of jobs, as well as the income and pollution generated by the other sectors are approx. 50% of the sum of the activities in the designated sectors (agriculture, mining, fisheries and tourism).

Urban area

The activities in the urban area are not singled out to one sector, but divided over some of the above sectors. However, the development options are strongly influenced by the developments of the city. Out of the total population of 600,000 in the Pesisir Tropicana Region, approximately 300,000 live in Portharbor, which covers only an area of 20 km². In the recent past, there was a high influx of rural people towards Portharbor, which resulted in non-regulated urbanization in the outskirts of the city, especially on the floodplain of Kali Migraine and on part of the coastal area.

The availability of skilled labour is estimated at 40% of the projected population growth rate.

Storm water run-off and 60% of the household waste water discharges by drains and canals to a waste water treatment plant, where it is treated before being discharged into Bay Teluk. The remaining 40% is discharged directly into the Bay.

Exercise Policy Analysis

Phase 2

Establishing criteria

Questions:
11. Identify the criteria you need for evaluating the alternatives. (Answer)
Phase 3

**Identifying Alternatives**

Questions:

12. Formulate a zero-alternative of Pesisir Tropicana. *(Answer)*
13. What type of scenarios are of relevance for Pesisir Tropicana. *(Answer)*

Read the information on development options in Pesisir Tropicana

14. Which alternative investments can be identified? *(Answer)*

Read the information on boundary conditions in Identifying Alternatives

15. What are the boundary conditions of development of Pesisir Tropicana? *(Answer)*

---

**Development options in Pesisir Tropicana**

Future development may follow various options. There are strong demands for urban expansion, which can be realized either in the existing urban area or in a new residential area along the beach, as indicated on the map. The construction of a new port for the export of cassiterite (tin-ore) from the tin-mines along the Kali Migraine is another option (currently the cassiterite is exported through the small commercial harbour of Portharbor). To stimulate the regional economy and boost foreign exchange earnings, tourism is a third option. Through aquacultural development the local employment and food production can be improved. Agricultural development, through reclamation activities in Bay Teluk (impoldering) is a further option as well as double cropping, on the condition that the irrigation system is improved and the water of the dam in the Rio Pusing can be used exclusively for irrigation. Finally, the creation of a national marine reserve east from Cape Rock can be considered. The aim of such a reserve is to protect the coral reefs from the negative effects of increased economic activities (industrial, agricultural, aquacultural, and urban development, as well as intensive tourism).

---

**Urban area: Residential development**

There is considerable interest in new residential districts. Investment costs associated with such a development would be 9.2 MUlc/1000 residents.
**New cassiterite loading facility**

It is expected that the cassiterite output can be raised to 2 million tons per year, for which the existing port and its handling facilities at Portharbor will be too limited. Therefore, the construction of a new port east of the existing port is foreseen, where handling of the cassiterite and shipping to the external market will take place. It will be a relatively small port with a single loading facility. Cassiterite will be transported to the port by barges, for which the Kali Migraine needs to be regulated. The port and related facilities would generate foreign exchange, since primarily international vessels will use this port. Foreign currency generated by such a port would be considerable. However, the new port and the increased number of vessels would also imply an increase of waste in the waters. The development of the cassiterite port would require investments in the order of at least 100 MULc. Smaller investments are considered not useful. The Cassiterite Dredging Company has also plans to construct an ore processing plant. This plant requires an investment of 150 - 300 Mulc, and will completely be covered by the company in their investment plan. However, this is only possible if there is a constant supply of electricity from the Rio Pusing dam.

**Tourism: hotels**

There is no provision for any significant expansion in the tourism sector, since the existing hotels in Portharbor are inappropriate for any potential tourist market. The development of new tourist resorts is possible outside the urban area. Possible locations are at Sandy Point, the beach between Portharbor and Cape Rock (wide sandy beach), and the area just north of Hillyville. It is expected that the proposed touristic development will attract many international tourists and therefore foreign currency.

**Aquaculture**

There is no opportunity to further develop the traditional fishing activities, whereas the expected local demand will only grow slightly. The recently started aquacultural activities show promising results, and the potentials are far from utilized. The estimated investment costs are 40 M Ulc/km². The potential production level for aquaculture is 1.2 kg/m², with a corresponding economic value of 15,000 Ulc/ton. The output from the aquaculture ponds would be for local consumption as well as for export for further processing. Because aquaculture can be considered a kind of industrial development, there is a relatively high rate of return for investments, but the number of generated jobs will be limited.
Agriculture

The areas in and around Bay Teluk have a small agricultural production. However, agricultural production in the Bay may increase considerably when some investments are made. The new dam gives the option of double cropping but then also an improvement of the irrigation system is needed. If the polder is not constructed, the existing farmland west of the Kali Migraine can be improved by intensive irrigation. This will cost in the order of 60 Mulc. Of course, this is only possible when sufficient water is available at the moment it is needed for the rice. This means in fact that the water in the Rio Pusing reservoir has to be stored in the months April - June, and should be used mainly in the end of March/beginning of April and in October.

The required investments will give a relative small rate of return for income, but it will generate many jobs in the rural sector.

National marine reserve

In order to protect the coral reefs and other marine life in the region, and also to provide an attraction to local and international tourists, the area just outside Bay Teluk, east of Cape Rock, is proposed to receive the status of a National Marine Reserve. The establishment of such a reserve would require more stringent water quality standards at that location.
Exercise Policy Analysis

Phase 4

Evaluating Alternatives

To simulate the use of specialized, an educational tool is incorporated in the free CRESS software. To help you evaluating your alternatives, please download and install CRESS on your local machine. Start the program, go to "Demo Coastal Zone Management", and to "Pesisir Tropicana". Here, you can investigate the effects of investments in areas.

Questions:
16. Determine the effects of various alternatives. (Answer)
17. Would a B/C ratio give sufficient information to make a sound decision on investment in Pesisir Tropicana? (Answer)

Exercise Policy Analysis

Phase 5

Ranking Alternatives

18. Make a scorecard. Does the scorecard give sufficient information to make a sound decision? (Answer)

References
Literature cited


Further reading

Books


Information on the web

- School of Public Policy - George Mason University: [http://policy.gmu.edu/](http://policy.gmu.edu/)

- Analysis of Public Perceptions of Canadian Coastal and Ocean Management Policy and Practice: [http://www.chebucto.ns.ca/~ar120/coa.html](http://www.chebucto.ns.ca/~ar120/coa.html)

Answers Policy Analysis
The steps in problem analysis can be done simultaneously to improve the speed of decision making

Answer

○ true
○ false

To be able to make a good delimitation of the problem, a good orientation on the problem is indispensable. The same holds for the problem definition and delimitation.

Consider the problem of oil and gas exploration from under a large intertidal wetland. Imagine that the government needs the oil and gas as it is a major source of income for the state, but local people fear the decline of nature in such an international important nature reserve. Decline in nature might occur due to the bottom subsidence (and flooding) which will occur in the area according to some geologists.

Answer

a) Criteria should be as detailed and objective as possible. So, the 'extent' of something is rather vague and should be avoided. The other three are objective quantitative measures and are preferred. However, the average subsidence, does not give information related to the decline of nature. A large subsidence taking place locally and a small subsidence taking place globally, can have completely different results. Thus, this criterion is also disregarded.

b) Other criteria might be:

- the chance of extinction of rare species due to flooding of their breeding grounds
- the area affected by subsidence, as a percentage of the total
- the speed of subsidence related to the 'elasticity' of nature (how fast can nature restore the subsidence by import of sediment)
- the size of the project benefits for the government, relative to other incomes.

Many other criteria can be thought of, depending on the exact circumstances and the stakeholders.
**Are these statements correct?**

- A policy, implemented some time ago, can exist already. The zero-alternative means that the business will be as usual; there will be no change in policy. **Correct**
- A scenario describes uncertain developments outside the scope of the policy makers. Examples: the amount of sea level rise, macro economic development and international relations (war). **Correct**
- It is of no use to describe and evaluate alternatives which have no chance to survive in the decision making process. You should try to describe only realistic alternatives. **Correct**

**Are the following statements correct or not:**

<table>
<thead>
<tr>
<th>Correct</th>
<th>Incorrect</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

- To prevent dune erosion, the beach is nourished. The beach becomes broader and attracts more tourists; this is a *side-effect*. **Correct**
- When studying coastal protection measures, to apply beach nourishments is an alternative. Sand can be used that is being dredged from a nearby access channel. The dredging costs don't have to be taken into account in the analyse as they are *sunk-costs*. **Correct**
- A government chooses to use a dune area for water treatment plants. The area is also very suitable for recreation, but there is no access road. The land is already public property, so, the total costs of the development will only be 100,000 dollar to build the plant and connect it to the existing water service pipes. **Correct**

Touristist recreation also generates money for the society; the land has *opportunity costs*. For example, if the land could be auctioned (and privately exploited for recreation) for 500,000 dollar, these are the *opportunity costs*.

**How suitable are aggregated methods to rank alternative solutions in the case of the development of a port terminal in an urbanized area, considering the client (decision maker) is the major?**

Usually, these methods are unsuitable in such cases. The aggregated methods have *limitations*, especially the ones that produce singly summary values, which makes it difficult for the major to make a balanced decision which reckons the diverging interests of a range of involved stakeholders.
**Exercise Policy Analysis Answers Phase 1**

1. **Project initiator**

Pesisir Tropicana is a fictive region in a fictive developing country. Improvements in the economic structure are therefore of prime priority. So the project initiator is responsible for the economic structure of the Pesisir Tropicana region. This is normally the responsibility of public authorities at various levels: municipality, provinces, state.

As indicated at the start of the exercise, a loan of the World Bank is available for improving the (economic) conditions. So, also (a representative of) the World Bank could be the project initiator. In other words, there is a wide range of (combinations of) project initiators possible.

For this exercise, we assume that a combination of "Regional Authorities" have the task to improve the economic structure of the region.

2. **Aspects**

Among others, the following aspects are of relevance:

- Fish and fisheries
- Wildlife
- Natural vegetation
- Agriculture
- Animal husbandry
- Climate
- Hydrology
- Soils
- Population
- Energy
- Tourism
- Industry
- Services

3. **Future developments**

Possibilities for future developments are, amongst others:

1. *Urban expansion.* The population will grow. These people need to be given proper shelter and sanitary facilities in new urban areas, which can be located either in the existing urban area or in a new residential area along the beach;
2. *A new port.* This is a requirement for industrial expansion: to increase the export of cassiterite (tin-ore) from the tin mines along the Kali Migraine (currently the
cassiterite is exported through the small commercial harbour of Portharbor). This will create a lot of jobs and opportunities, but will also have a negative impact on the environment;

3. Industrial expansion, which especially refers to expanding tin-mining. A lot of jobs will be created, but also a lot of extra pollution (heavy metals) will be introduced. To limit this, tailing treatment plants are needed;

4. Tourist facilities, as to stimulate the regional economy and to boost foreign exchange earnings. Energy and water supply will have to be introduced, but also new hotels. Possibilities are near Cape Rock and Hilly Villy. However, also some pollution will be introduced;

5. Development of aquaculture, as to improve local employment and food production. Aquaculture will have high financial output, but only a limited number of jobs will be generated;

6. Agricultural development, through:
   - reclamation of part of Bay Teluk through inpoldering. Disadvantage is that the mangrove would disappear;
   - double cropping, on the condition that a dam will be built in the Rio Pusing, and that the water irrigation) can be used exclusively for irrigation. In addition, the irrigation system network needs to be improved;
   An intensified agriculture will also lead to an increased pollution;

7. Creation of a national marine reserve in Bay Teluk, as to protect the coral reefs from the negative effects of increased economic activities (industrial, agricultural, aquacultural, and urban development), as well as to promote eco-tourism. However, it will demand for limited growth of all other activities up to a certain extent;

8. Waste water treatment plants, as to reduce pollution (E-coli, heavy metals) in Bay Teluk (it is difficult to control phosphates, as these originate from diffuse agricultural sources);


10. Higher wages for local government employees, as to combat corruption;

11. More police to decrease the criminality rates

4. Physical boundaries

In this exercise it is rather straightforward to take the Pesisir Tropicana area as indicated on the map.

5. Disciplines

The following disciplines are of relevance for the analysis:

- economy;
- ecology;
- sociology;
- agriculture;
- civil engineering;
6. Possible stakeholders

Possible stakeholders are (representatives of) those who have interest in the proposed developments. In principal, interest groups originate from:

- public service: three levels of public authority are possible (national, provincial, rural/municipal);
- NGO's (non-governmental organizations: unions, associations, pressure groups, etc.);
- private companies.

For the exercise, we have identified the following stakeholders:

- Pesisir Tropicana Fisheries Associations (NGO)
- Farmers Association (NGO);
- Cassiterite Dredging Company (tin industry);
- Municipality of Portharbor (public authority);
- Province of Pesisir Tropicana (public authority);
- Ministry of Economic Affairs (public authority);
- Ministry of Planning (public authority);
- Pesisir Tropicana Rural Council (NGO);
- Portharbor Port Authority (private organization);
- Tropical Shrimp, Inc. (aquacultural industry)
- Friends of Bay Teluk (NGO)
- Labour Union (NGO)

7. Decision maker(s)

The project initiator should indicate who should make the decision:

- project initiator;
- (selection of) stakeholders
- combination.

In this exercise we assume that the stakeholders will make a decision, based on the information you will provide as project analyst.

8. Indicators

Possible indicators (units in between brackets) are:
- number of jobs (-);
- income per head (Ulc);
- employment rate (%)
- water quality parameters
  - phosphate content
  - air content
  - E-coli content
  - algae concentration;
- area of mangrove (ha)
- tin production (in tonnes or in MULc)
- rice production (tonnes per ha)
- number of cattle (-)
- number of cattle (-)
- number of tourists (-)
- number of hotels (-)
- fish (tonnes per annum; Ulc per ton)
- etc. etc.

Actually, before the indicators (and the zero situation) can be defined, there should be an idea about the desired situation. For instance, is employment the main objective of the project, or environmental aspects?

For this exercise, we restrict the investment possibilities to the following sectors:

- Tin mining
- Agriculture
- Fisheries
- Residential development
- Creation of a national marine reserve through investments in water treatment plants

The indicators needed are (units are indicated in between brackets):

- Income (MULc)
- Income per head (Ulc)
- Number of jobs (-)
- Employment rate (%)
- Ecoli
- Heavy metals
- Phosphates
- Mangrove area (ha)

9. Zero situation
Inhabitants Portharbor: 300,000
Inhabitants Pesisir Tropicana region: 300,000
Availability skilled labour: 40% of the estimated growth rate
Water treatment Portharbor: 60% of household waste water is treated, 40% is discharged directly into Bay Teluk
Water quality Rio Pusing
Water quality Kali Migraine
Water quality Bay Teluk

10. Desired situation

In this stage, the desired situation for Pesisir Tropicana can only be described in vague terms. Undoubtedly, the general aim of the possible investment of 800 MUlc is to improve the socio-economic and ecological situation as optimally as possible:

- improve water quality to international standards
- increase employment rate
- increase income per head
- increase agricultural output
- increase area of mangroves in Bay Teluk

<table>
<thead>
<tr>
<th>Sector</th>
<th>Economic value per year (in MUlc)</th>
<th>Number of jobs</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tin-mining</td>
<td>100</td>
<td>15,000</td>
<td>No on site treatment of cassiterite</td>
</tr>
<tr>
<td>Agriculture</td>
<td>55</td>
<td>60,000</td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td>30</td>
<td>30,000</td>
<td>6000 boats</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tourism</td>
<td>15</td>
<td>7,500</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>100</td>
<td>56,000</td>
<td></td>
</tr>
</tbody>
</table>
### Exercise Policy Analysis Answers Phase 2

#### 11. Criteria

Criteria can be classified by group:

<table>
<thead>
<tr>
<th>Group</th>
<th>Judgement parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature</td>
<td>Coral reef quality</td>
<td>(-)</td>
</tr>
<tr>
<td></td>
<td>Mangroves</td>
<td>m²</td>
</tr>
<tr>
<td></td>
<td>Number of species</td>
<td>#</td>
</tr>
<tr>
<td></td>
<td>Number of fish</td>
<td>#</td>
</tr>
<tr>
<td></td>
<td>Erosion rate</td>
<td>m²/yr</td>
</tr>
<tr>
<td>Pollution</td>
<td>E-coli bacteria</td>
<td>ppm</td>
</tr>
<tr>
<td></td>
<td>Heavy metals</td>
<td>ppm</td>
</tr>
<tr>
<td></td>
<td>Phosphates</td>
<td>ppm</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>Employment rate</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Number of people at risk</td>
<td>#</td>
</tr>
<tr>
<td></td>
<td>Non-cultivated area</td>
<td>ha</td>
</tr>
<tr>
<td></td>
<td>Length of road</td>
<td>km</td>
</tr>
<tr>
<td></td>
<td>Literacy</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>Life expectancy</td>
<td>yr</td>
</tr>
<tr>
<td></td>
<td>Number of houses</td>
<td>#</td>
</tr>
<tr>
<td>Financial</td>
<td>Energy demand</td>
<td>kWh</td>
</tr>
<tr>
<td></td>
<td>Total income</td>
<td>MUlc</td>
</tr>
<tr>
<td></td>
<td>Water demand</td>
<td>m³</td>
</tr>
<tr>
<td></td>
<td>Total investment</td>
<td>MUlc</td>
</tr>
</tbody>
</table>

For the exercise, we defined the following judgement parameters:

1. Total income (MUlc)
2. Income per head of population (ULc)
3. Number of jobs (*1,000)
4. Employment rate (%)
5. E-coli bacteria
6. Heavy metals
7. Phosphate
8. Mangrove area (ha)
12. Zero alternative for Pesisir Tropicana

Within the formulation of the zero alternative, it should be decided if autonomous development are included or not. If not, than the zero alternative is the same as the existing situation.

In this exercise, we include the autonomous developments of the Pesisir Tropicana Region as follows:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Natural growth rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tin mining</td>
<td>1.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1.5</td>
</tr>
<tr>
<td>Fisheries</td>
<td>2.0</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>0.0</td>
</tr>
<tr>
<td>Tourism</td>
<td>1.0</td>
</tr>
</tbody>
</table>

13. Scenarios

Scenarios reflect exogene influences. For Pesisir Tropicana, scenarios could be based on assumptions on:

- population growth (percentage);
- price of commodities (fluctuation in tin price, either positive or negative);
- pollution.

For the exercise, we assume a scenario based on population growth and price of tin as follows:

1. Population growth = 3.5%
2. Yearly increase of tin price: 1.0 %
14. Alternative investments

Alternative investments are in:

- Urban expansion;
- New port facilities;
- Expansion of tin-mining;
- Tourist facilities;
- Aquaculture;
- Fisheries;
- Agriculture;
- National marine reserve;
- Waste water treatment plants;
- Tailing treatment plants;
- Flood control;
- Higher wages;
- More police.

15. Boundary conditions

It will not be possible to implement all alternative investments in such a way that the potentials of each option can be utilized fully, as (amongst others):

- the total available budget will never be sufficient to implement all options to their maximum potential;
- the effects of increased activities in one sector may negatively influence the developments in other sectors (like: increased industrial activity --> increased pollution -- > negative effects for aquaculture, national reserve, etc.);
- limited available labour.

Further, trying to implement all these options may also lead to conflicts in planning and resources management. For example, is there enough coastal land for the development of residential housing, tourist hotels and aquaculture? How might the construction of a new port and the increased shipping affect existing fisheries and the conditions of the national reserve? If increasing industrial activities will cause serious water pollution, what is its effect on agriculture, fisheries, environment and recreational activities? Which measures should be taken to prevent or reduce these conflicts, and how can an optimal balance be achieved?

For the exercise, we consider that boundary conditions follow from objectives, like for instance:

- Good employment rate on short and long term
- Good development of especially agriculture and fisheries
- Good development of income per head on the long term
- Clean water for irrigation (secondary objective)
- Protection of mangrove (secondary objective)

Then the following alternatives can then be defined:

1. Investment in mining and tourism, as to create good employment + investments in agriculture and fisheries. To decrease the negative effects of pollution because of mining (heavy metals) and tourism and fisheries (E-coli), investments are also made on waste water treatment and tailing treatment;
2. Investment in fisheries, agriculture and aquaculture + waste water treatment plants.

Exercise Policy Analysis Answers Phase 4

16. Effects of the alternatives

The alternatives are based on the earlier defined scenario

1. population growth of 3.5%
2. yearly increase in tin price: 1.0%

In addition, we assume the time-horizon set at 2020.

Zero alternative (no investment; autonomous development)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
<td>459 MUlc</td>
</tr>
<tr>
<td>Income per head of population</td>
<td>432 Ulc</td>
</tr>
<tr>
<td>Number of jobs</td>
<td>227,000</td>
</tr>
<tr>
<td>Employment rate</td>
<td>53.4%</td>
</tr>
<tr>
<td>E-coli bacteria</td>
<td>1,486</td>
</tr>
<tr>
<td>Heavy metal</td>
<td>1,120</td>
</tr>
<tr>
<td>Phosphates</td>
<td>1,330</td>
</tr>
<tr>
<td>Mangrove area</td>
<td>17,760</td>
</tr>
</tbody>
</table>
Alternatives 1 and 2 are based on objectives that aim at good employment rates, agriculture and fisheries, and income generation.

**Alternative 1: Tourism and mining**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment (MUlc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>67</td>
</tr>
<tr>
<td>Tourism</td>
<td>50</td>
</tr>
<tr>
<td>Fisheries</td>
<td>150</td>
</tr>
<tr>
<td>Agriculture</td>
<td>150</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>201</td>
</tr>
<tr>
<td>Waste water treatment</td>
<td>150</td>
</tr>
<tr>
<td>Tailing treatment</td>
<td>32</td>
</tr>
</tbody>
</table>

**Criterion**

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
</tr>
<tr>
<td>Income per head of population</td>
</tr>
<tr>
<td>Number of jobs</td>
</tr>
<tr>
<td>Employment rate</td>
</tr>
<tr>
<td>E-coli bacteria</td>
</tr>
<tr>
<td>Heavy metal</td>
</tr>
<tr>
<td>Phosphates</td>
</tr>
<tr>
<td>Mangrove area</td>
</tr>
</tbody>
</table>

**Alternative 2: Fisheries, agriculture and aquaculture**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment (MUlc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0</td>
</tr>
<tr>
<td>Tourism</td>
<td>0</td>
</tr>
<tr>
<td>Fisheries</td>
<td>175</td>
</tr>
<tr>
<td>Agriculture</td>
<td>254</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>208</td>
</tr>
<tr>
<td>Waste water treatment</td>
<td>158</td>
</tr>
<tr>
<td>Tailing treatment</td>
<td>5</td>
</tr>
</tbody>
</table>

**Criterion**

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
</tr>
<tr>
<td>Income per head of population</td>
</tr>
<tr>
<td>Number of jobs</td>
</tr>
</tbody>
</table>
Alternatives 3 and 4 are based on objectives that aim at rise in income, industrial development and stable employment rate on the short and the long term.

### Alternative 3: Short term (2010)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment (MULc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>450</td>
</tr>
<tr>
<td>Tourism</td>
<td>0</td>
</tr>
<tr>
<td>Fisheries</td>
<td>0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>115</td>
</tr>
<tr>
<td>Waste water treatment</td>
<td>25</td>
</tr>
<tr>
<td>Tailing treatment</td>
<td>210</td>
</tr>
</tbody>
</table>

### Criterion

<table>
<thead>
<tr>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total income</td>
</tr>
<tr>
<td>Income per head of population</td>
</tr>
<tr>
<td>Number of jobs</td>
</tr>
<tr>
<td>Employment rate</td>
</tr>
<tr>
<td>E-coli bacteria</td>
</tr>
<tr>
<td>Heavy metal</td>
</tr>
<tr>
<td>Phosphates</td>
</tr>
<tr>
<td>Mangrove area</td>
</tr>
</tbody>
</table>

### Alternative 4: Long term (2040)

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment (MULc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>450</td>
</tr>
<tr>
<td>Tourism</td>
<td>0</td>
</tr>
<tr>
<td>Fisheries</td>
<td>0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>115</td>
</tr>
</tbody>
</table>

### Employment rate

- Short term (2010): 100.8%
- Long term (2040): 95.3%
### 17. B/C Ratio

No! The B/C ratio only uses information that is expressed in monetary terms: MUlc's. So, only information from the judgement parameter "Total Income" could be used, whereas information from the other judgement parameters (income per head, number of jobs, employment rate, E-coli, heavy metal, phosphate, mangrove area) would be neglected completely. A decision, based on the B/C ration can therefore only be relevant for a decision maker who would be solely interested in the "Total Income". Such a decision maker can be considered as non-existing.

### Exercise Policy Analysis Answers Phase 5

#### 19. Score-card

Indicating the maximum positive (Green colour) and minimum negative (red colour) effects gives the following score card:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Zero alternative</th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Alternative 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste water treatment</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tailing treatment</td>
<td>210</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Criterion</strong></td>
<td><strong>Value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total income</td>
<td>900 MUlc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income per head of population</td>
<td>607 Ulc</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of jobs</td>
<td>467,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment rate</td>
<td>78.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-coli bacteria</td>
<td>1,446</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy metal</td>
<td>2,320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td>2,780</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangrove area</td>
<td>9,773</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This score card, however, does not straightforwardly indicate the best alternative, as there is no single column filled with green (best) scores of judgement parameters. To choose a 'best' alternative, a person has to determine the weight of each criterion. The application of weights, determining scores and the final 'best' alternatives can be supported by computer programs.

<table>
<thead>
<tr>
<th></th>
<th>Mining</th>
<th>Tourism</th>
<th>Fisheries</th>
<th>Agriculture</th>
<th>Aquaculture</th>
<th>Waste water treatment</th>
<th>Tailing treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Judgement parameter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total income (MUlc)</td>
<td>459</td>
<td>579</td>
<td>561</td>
<td>556</td>
<td>900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income per head of population (Ulc)</td>
<td>432</td>
<td>545</td>
<td>528</td>
<td>652</td>
<td>607</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of jobs</td>
<td>227,000</td>
<td>410,000</td>
<td>428,000</td>
<td>325,000</td>
<td>467,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment rate (%)</td>
<td>43.4</td>
<td>96.6</td>
<td>100.8</td>
<td>95.3</td>
<td>78.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-coli bacteria</td>
<td>1,486</td>
<td>0</td>
<td>0</td>
<td>1056</td>
<td>1,446</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy metal</td>
<td>1,120</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2,320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphates</td>
<td>1,330</td>
<td>5,335</td>
<td>6,788</td>
<td>2,330</td>
<td>2,780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mangrove area</td>
<td>17,760</td>
<td>22,367</td>
<td>22,629</td>
<td>20,590</td>
<td>9,773</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>