ABSTRACT

Whilst land reclamation receives increasing attention as a feasible urban solution for coastal development, conclusions on the social and economic effects of reclamation projects are not clear. A straightforward evaluation of these impacts is not easy to achieve, mostly because effects are wide ranging, heterogeneous and difficult to measure in the long term. A comprehensive assessment of different welfare effects can however be fostered based on specific appraisal techniques.

Following a cost-benefit analysis approach, the article illustrates a framework for the evaluation of reclamation projects. It addresses the most important elements to consider in project appraisal, offers an overview of the different types of effects generally recognisable and shows how an integrated monetary valuation of the project can eventually be estimated.

Two case studies are then analysed using the proposed model: a port development project (Maasvlakte 2, Rotterdam, the Netherlands) and a beach reclamation project (Amager Strand, Copenhagen, Denmark). The core conclusion drawn from the case studies is that reclamation projects may cause relevant impacts also outside the sector for which they are specifically implemented. In many cases, economic, strategic, environmental and other social effects directly or indirectly related to reclamation projects are substantial. The report indicates that a thorough identification and measurement of project effects is fundamental for clarifying the comparative advantages that reclamation offers with respect to alternative spatial-development plans. Comprehensive and consistent evaluation of the impacts on society can contribute to better consideration of reclamation as an urban solution and an investment opportunity for both private and public stakeholders.

INTRODUCTION

Port cities have long struggled to accommodate urban growth given the difficulties of finding space within geographically constrained and densely populated coastal areas. However, thanks to innovative dredging techniques introduced over the last few decades, land can nowadays be reclaimed under advantageous economic conditions (Kolman, 2012). Having to cope with pressing urbanisation trends, port cities have a lot to gain from the more competitive costs of reclamation.

Reclaimed waterfront areas can make strategic spatial development plans feasible in overcrowded areas and be used to accommodate the demand for new housing, employment, transport and other urban facilities. This enables cities to allay congestion, enhance urban services and so remain attractive locations for both people and businesses. These functions are of relevance for the entire community, since these enhancement have positive returns not only for investors and users, but for the quality of life and competitiveness of the entire city.

Nonetheless public and private stakeholders have expressed concern about the impacts of reclamation projects. In addition, a lack of knowledge about how such effects can be
Relevant issues that need to be addressed are:

- How are costs and benefits distributed amongst several stakeholders?
- Can costs and benefits be comprehensively weighed, so as to assess whether a reclamation project is profitable from a social point of view?

This article shows how reclamation projects can be evaluated following a Cost-Benefit Analysis (CBA) approach beginning with the presentation of the CBA analytical framework. Thereafter follows reviews of two projects: Maasvlakte 2, a major port development project at Rotterdam, the Netherlands; and Amager Strandpark, a beach reclamation project in Copenhagen, Denmark.

COST-BENEFIT ANALYSIS OF RECLAMATION PROJECTS

Economic project assessment evaluates important information on an investment or policy plan and its social and economic consequences. It represents core tasks with respect to decision processes regarding investment projects, as it allows making resource allocation choices on the base of relevant economic factors. Cost-Benefit Analysis (CBA) is arguably the technique most commonly used for economic project assessment. The various advantages generally ascribed to CBA are:

- It promotes the assessment of all social impacts resulting from a project. Being based on a broad welfare-economical approach, CBA lets positive and negative effects be identified and weighed for potentially all relevant groups in society.
- CBA entails the assessment of project effects in a common unit of measurement, i.e., money. This allows weighing heterogeneous effects against each other, effects that are not immediately comparable.
- CBA illustrates how a project’s costs and benefits are distributed across different social groups. This helps define the financial contribution to be given by public and private stakeholders, or to determine a fair compensation to parties that experience a project’s negative consequences.

In view of the above, CBA appears well suited for investigating the effects and the welfare value of reclamation projects. To do this means looking at the impacts reclamation projects produce not only for the specific sector for which land is being provided, but for the whole socio-economic context that is influenced by the project.

Note as well that what produces value for society are not the reclamation activities themselves, but the type of services and infrastructures developed on reclaimed land. Reclamation activities provide the basic input – land – to the project. But the focus of the analysis should be the spatial development plans reclamation makes possible and the impacts that generate directly and indirectly from such plans (Figure 1). After examining current literature on CBA (Eijgenraam et al., 2000a, 2000b; Pearce et al., 2006; EC, 2008), the steps leading to a socio-economic evaluation of reclamation projects are described below (Figure 2). The first step of the analysis starts with the formulation of the CBA, i.e., by elaborating key information necessary throughout the appraisal work.

The second step looks into the services that are ultimately delivered on the reclaimed land and helps understand what activities will take place after the reclaimed area is developed and hence which type of markets and stakeholders will be directly affected by the project. The project’s impacts will depend on the effective consumption of these services. Therefore, how the demand for project

![Figure 1. Flow from reclamation of land to project impacts.](image_url)
services will develop over time must be determined in advance.

On the basis of this information, and the prospected market dynamics, step 3 focuses on the analysis of the socio-economic effects the project generates over its entire life span. At this point in the evaluation, all agents or groups of stakeholders influenced by the project are identified. For each group, the effects are described and quantified in their physical dimension.

In step 4, the project effects are translated into corresponding welfare changes. In other words, the physical effects previously determined are valuated in monetary terms on the basis of the willingness-to-pay (WTP) that firms and households have for each effect. If possible, existing markets are considered where the WTP is reflected by market prices or can be observed from the behaviours of suppliers and customers. Otherwise, when an effect is related to a good for which a market does not exist (e.g., air pollution, noise, travel-time and such), specific valuation methods such as surveys, experiments, and so on, need to be used (see EC, 2008; Pearce et al., 2006).

In step 5, a cost-benefit set-up is produced by considering the stream of negative and positive effects (costs and benefits) over the entire investment horizon. As the effects involve different time scales, they are all discounted to a unique moment in time, so as to calculate the project Net Present Value (NPV). The outcome of economic appraisal of projects is usually characterised by some degree of uncertainty, often as a result of the

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Table I. Classification and short description of project effects.

<table>
<thead>
<tr>
<th>Welfare effects</th>
<th>Direct effects</th>
<th>Indirect effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>Profit earned through service provision by the project operator (business case).</td>
<td>Consequences stemming from the traffic induced by the project: scale-economies and/or congestion in transport network, pollution, etc.</td>
</tr>
<tr>
<td>Users</td>
<td>Users benefit from increased quality/quantity of services delivered by operator (consumer surplus): e.g. from lower generalised transport costs, improved production outputs, better environmental/recreational services, etc.</td>
<td>Impacts indirectly produced on the local economy. Infrastructure investments can contribute to attract new firms or workers. As the market expands, competitive advantages may generate as consequences of scale economies, knowledge spillovers, labor pooling, etc.</td>
</tr>
<tr>
<td>Third parties</td>
<td>Effects for people not directly involved in the project: e.g. pollution and other environmental externalities experienced by residents.</td>
<td>New jobs can be created in a situation characterized by the presence of structural unemployment. Effects on employment typically involves low-skilled workers.</td>
</tr>
</tbody>
</table>

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Figure 3. Projected total throughput in 2030 – Port of Rotterdam (Source: PRA, 2011).
difficulty of deriving reliable cost-benefit estimates over relatively long periods of time as well as the general difficulty of forecasting how a situation develops after a project is implemented. Hence, in step 6 a sensitivity analysis is usually conducted by examining how the NPV responds to changes in the value of key variables or of factors presenting high uncertainty.

Following the framework for the evaluation of infrastructure projects of Eijgenraam et al. (2000a, 2000b), project effects are distinguished in two broad categories: direct effects and indirect effects. Direct effects are examined by looking at the parties and stakeholders that are directly affected by the project, while indirect effects are classified into different typologies. Table I gives an overview of the various categories of effects, providing compact definitions along with intuitive examples.

Direct effects are “those arising from the construction, use and presence of project services” (Eijgenraam et al., 2000a). Different types of stakeholders are directly influenced by the project:

- **Operator.** In the first place, a reclamation project involves investors/landowners and suppliers of the project services. Albeit these functions can be executed by different agents, for simplicity the term “operator” will be used to represent them all together as single stakeholder, whose objective is to maximise the return from the investment project. From the operator point of view, the stream of costs is weighed against revenues, resulting in the (net) operating profit.

- **Users.** The provision of new/better services is at the core of infrastructure development projects. The users of services are normally those enjoying the larger benefits from investment projects. By investing in infrastructure, the service supplier (operator) might be able to sell more project services and/or more efficiently. This will lead to a welfare improvement, which is typically measured as “Consumer Surplus”. As the unit price of a service decreases, for instance, users benefit by paying relatively less than what they would pay in the base case. On the other hand, if the producer continues to sell at the same price, the producer retains the unit cost reduction and earns extra-profit (Producer Surplus).

- **Third parties.** These are agents other than the operator and the users of the services. Third parties may be directly influenced by the construction, use or presence of the infrastructure even though they are not involved in the project operations or are not using the services. Third parties can be residents, who experience negative project effects in the form of pollution, noise and/or positive effects in the form of increased housing values.

Indirect effects are represented by “the consequences of a project that are not directly related to the project, but which instead flow from the direct effect” (Eijgenraam et al., 2000b). Indirect effects are commonly seen as advantages that spread from the project service sector through the rest of the economy by means of market transactions. It is important to note that indirect welfare
The Port of Rotterdam is the largest port in Europe. In 2012, its total throughput reached 440 million tonnes per annum and a market share of almost 38% in Northwest Europe (PRA, 2012). The Port has a very strong position both as global hub and industrial cluster and handles very large volumes of cargo across all main sectors (containers, dry bulk, liquid bulk). The Port of Rotterdam Authority (PRA), a government corporation jointly owned by the Municipality of Rotterdam and the Dutch State, is the manager, operator and developer of Rotterdam port and industrial area. Facing increasing volumes of cargo, PRA decided to further develop the port complex. Along with an intensification of activities in the existing port, a 20% expansion of the port area was considered necessary to fully meet handling capacity demand for the next 30 years (PRA, 2011). Maasvlakte 2 (MV2) is the answer PRA designed to implement such expansion. The project consists of reclamation of 2000 ha in front of the existing port. Half of the area is for commercial use, offering allocable sites for three main sectors: container handling, chemical industry and distribution.

The general objectives of the project are: to overcome capacity constraints in the existing port to confront an expected increase in cargo flows; and to limit the exposure of people to environmental externalities related to port activities. Considering factors such as economic growth, volume of world trade, oil changes arise only in particular situations, e.g., in the presence of market failures (Eijgenraam et al., 2000a, 2000b). The impacts generally included in CBA as indirect effects are:

- **Network effects.** These are especially relevant for transport infrastructure projects such as port development. Transport infrastructures are typically part of a broader network and represent a part such as a line connection between two places or a hub that is connected with multiple routes. As a transport infrastructure is developed, the induced traffic (i.e., the extra volume of goods or passengers using the new infrastructure) will flow either downstream or upstream the network to reach the final destination, producing consequences on the whole network to which it is connected. Depending on how the existing network capacity can accommodate the extra volume, network effects will be either positive or negative: positive, if the extra volume leads to a better or more efficient utilisation of the existing capacity; negative, if congestion emerges.

- **Strategic and locational effects.** Efficiency improvements generated through new infrastructures help increase the competitiveness of an economic system, with positive consequences on investment inflow and international trade. In some cases, infrastructure projects generate location advantages for businesses, contributing to attract new activities and investments from elsewhere. The inflow of new players can have positive consequences on the local economic system.

- **Employment.** During and after the implementation of a project, new workers are needed in the activities directly or indirectly related to it. If there is full employment, the increase in job demand is fulfilled by shifting workers already employed in other companies or regions (redistribution), which means no additional employment is created. On the other hand, in the case of structural unemployment a positive effect might result from the project. The analyses of the case studies proposed in the next section are meant to give insights into the types of effects resulting from projects with different purposes, as well as into the possible outcomes of an economic evaluation of reclamation projects.

**CASE STUDIES**

In order to illustrate how the CBA methodology can be used to evaluate actual projects, two cases studies are analysed here: one for a port development project and one for a recreation project. These were selected by considering the main space-related needs in coastal cities which are the most important drivers of reclamation activities. The analysis of the case studies is done on the basis of the framework described above. However, the evaluation is structured following two distinct types of analysis: the financial analysis and the socio-economic analysis.

Such analyses evidence different point of views which can be taken in project appraisal. The financial analysis is made on behalf of the owner/operator of the infrastructure and therefore uses the cash flow expected from the project to calculate the financial return on the investment. The socio-economic analysis considers all the effects for all relevant stakeholders in society, so as to determine the project contribution to the welfare of the region or country.

**MAASVLAKTE 2**

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Table II. Socio-economic effects of MV2.

<table>
<thead>
<tr>
<th>Welfare effects</th>
<th>Sign/magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct effects</strong></td>
<td></td>
</tr>
<tr>
<td>• Operator</td>
<td>Positive profit for port operator (PRA).  +</td>
</tr>
<tr>
<td>• Users</td>
<td>Welfare surplus from savings in generalised transport costs (container and chemical sectors). ++</td>
</tr>
<tr>
<td>• Third parties</td>
<td>Negative externalities from rising port activities (pollution, noise, sound…); costly natural compensation. +</td>
</tr>
<tr>
<td><strong>Indirect effects</strong></td>
<td></td>
</tr>
<tr>
<td>• Transport network</td>
<td>Scale economies and/or congestion occurring in the national hinterland network (depending on capability of transport infrastructure to accommodate extra cargo flows to/from the port). +/-</td>
</tr>
<tr>
<td>• Strategic effects</td>
<td>Improved accessibility and locational attributes attract new firms and workers into the local economy. Competitive advantages are expected from knowledge spillovers, labour pooling, and so on in the maritime and chemical industries. +</td>
</tr>
<tr>
<td>• Employment</td>
<td>Small impact on national employment, mostly involving low-skilled workers. +</td>
</tr>
</tbody>
</table>

Note: The table shows the direction (positive or negative) and magnitude of the different types of effects. As for magnitude, effects are distinguished as: moderately positive or negative (+ or –); very positive or negative (++ or --); and uncertain (+/-).

Financial analysis

The financial analysis of the project looks at the effect that MV2 has on PRA as the investor and owner of the new port area. Such analysis focuses on MV2’s cash-flow forecasts to determine the expected financial return that PRA obtains from the investment. The effect for PRA is represented by the net profit (or financial NPV) earned by the Authority over the investment horizon, integrated with the expenses that are avoided with respect to the base case (investments in existing port, maintenance of the original seawall and so on).

The distribution of costs and revenues from MV2 for the period 2006-2040 reflect the estimates that PRA made in the 2003 business case for MV2. On the cost side (negative quadrant) are the investment, maintenance and operating costs. All together these add up to € 2.9 billion. On the revenue side (positive quadrant) is the income PRA receives from port dues, rents and wharfage. For each year, the difference between costs and revenues is summarised by the annual cash-flow (black line). Applying a certain discount rate, the annual cash-flows can be discounted to a base year so as to derive the Net Present Value that MV2 has for PRA only.

Figure 7 shows that, as expected, the cash-flow develops over time from quite negative values, which are the result of the considerable investments for the initial construction, to positive values, which PRA starts obtaining as commercial sites become operative.

Revenues grow especially after 2020, the period where the container sector is expected to get closer to full market potentials. Investment costs appear distributed over more than 20 years, reflecting the phased plan for construction designed by PRA. PRA does not disclose information on revenues, applied discount rate, and NPV, so it is not possible to consistently analyse the financial return from the project. Although PRA is confident that revenues will greatly outweigh the costs of MV2, forecasts on future market demand have recently been revised downward, reducing the expected financial profitability of the project. In the light of this, the assumption is that MV2 has a (moderate) positive affect for PRA.

prices and environmental policy, PRA assumes four different economic scenarios for forecasting the development of cargo flows. As shown in Figure 3, both container/break-bulk and liquid-bulk appear to be the main growth markets. In the container sector, in particular, thanks also to the possibility that MV2 would offer to handle the largest ships, container handling could possibly pass from 25% to over 40% of total freight.

New space in the port complex is therefore required to meet the increasing demand of cargo handling services and chemical industrial functions. According to the prospected market developments, PRA expects the 1000 ha of MV2’s commercial area to be developed based on the following pattern of land use (Figures 4 and 5): container handling (60%), chemical industry (30%), distribution (10%). To reduce the risk of the investment, PRA will phase construction and investments out over 30 years’ time, trying to adapt land use and investment decisions to future market conditions. The first phase of construction was completed in 2013. This entailed elements such as the seawall and other basic infrastructures (roads, quays, rail tracks, and so on), and 400 ha providing space for three new container terminals. Following the effective demand for new port sites, other plots will be gradually developed in the period until 2030.

The project also involves accompanying measures such as compensation for project-related natural losses and interventions in the transport network directed towards a more efficient and clean hinterland transport system. Together with the strict environmental requirements imposed by PRA on settling companies, such measure contribute to make the port economy more sustainable, and should prevent a deterioration in the quality of life in the Rotterdam region.
Socio-economic analysis (CBA)

Socio-economic analysis takes into consideration all effects generated by MV2 that are relevant to Dutch society. Given that the local and national governments have strongly supported the project politically, and also in part financially, a national point of view is taken for the CBA of MV2. As the users of cargo or chemical products are located for a large part abroad, this implies disregarding the substantial forward effects of the project, spreading beyond national borders.

Users

Users of project services are fundamentally companies demanding container handling services and related logistic operations and users of chemical products. In the container sector, considerable capacity shortage would occur if MV2 were not developed (base case), resulting in increasingly congested, inefficient and overall costly terminal operations. Hence, the welfare effect of MV2 on users of handling services is given by the change in economic surplus resulting from the avoidance of such a potential bottleneck.

In the chemical sector, on the other hand, customers of settling companies would enjoy cost advantages because transportation of chemical products (raw materials, intermediate inputs, end products, ...) to Dutch users is cheaper from Rotterdam than from other port locations (without MV2, companies divert to Antwerp, Terneuzen, and so on, which implies higher transport costs for Dutch recipients).

However, CPB (2001a, 2001b) argues that potential Dutch users could be reached comparably well also from competing ports, suggesting that transport benefits for Dutch users are likely to be relatively small. Cluster benefits may also emerge in the port’s chemical industry as companies enjoy the advantages of being in close proximity to each other. Taken together, location advantages in the chemical sector seem limited compared to those in the container sector (CPB, 2001b).

MV2, mainly through savings in transport costs, is expected to positively contribute to sectors other than container/distribution and chemical (e.g., offshore decommissioning, direct reduction of iron, distribution and empty depots).

Third parties

The intensification of port activities that takes place through MV2 also affects parties that are not users or suppliers of project services. In a national CBA, this category of stakeholders basically refers to local residents or Dutch citizens negatively influenced by activities related to the construction, presence and use of MV2. The Environmental Impact Assessment provides the most information on MV2’s external effects. Important to consider are the consequences the project has on: landscape (view of industrial plants), recreational services (destruction/creation of beaches and other recreational areas), nature (coastal ecosystem services), and environment (air, water, sound, pollution). In total, external effects should be relatively low (CPB, 2001b), partially because of the large distance separating MV2 from urban and residential settlements.

Indirect effects

As a large-scale infrastructure project, MV2 entails considerable indirect effects on the Dutch social welfare:

- **Network effects.** As the port expands, increasing amounts of cargo will distribute from the port to the hinterland. Capacity is available across most network connections, so that increasing cargo flows can even result in scale economies for the infrastructure operators, and more frequent and efficient transport services for network users. Capacity shortage could instead emerge on the most used links (A15 highway, Betuweroute freight railway, etc.), with congestion and other negative consequences possibly arising. A gradual shift from road to transport modes with a lower environmental impact such as rail, barge and (for chemicals) pipelines is also predisposed for the future (see Figure 6). Overall, it is uncertain whether the hinterland network will be influenced positively or negatively. In any case, network effects can be considered of relatively small consequence, given that without MV2 transportation of cargo would take place anyway and might cover longer origin-destination distances (CPB, 2001b).

- **Strategic and locational effects.** Thanks to port development, the Dutch economy, and particularly the Rijnmond region, becomes more accessible and competitive. This improves the business climate, favouring new investments and attracting new companies. In perspective, the attraction/ expansion of a specialized, skilled workforce (sustained also through public investments in urban development and quality of life) can prove strategic for future regional specialization in the maritime and port industry, and hence further economic development of Rotterdam and Rijnmond.

- **Employment.** According to CPB (2001b), the local labour market is characterized by structural unemployment of low-skilled workers, which is arguably the result of a problem in the supply side – companies are willing to hire, but low-skilled workers do not have the required competences. Hence, the labour demand induced by MV2 could face the same sort of problem, in which case workers from other region will mostly be working at MV2 and its spin-off activities (only redistribution of workers across regions). Despite the weak impact on employment, MV2’s macro-economic consequences remain positive.

The study from CPB provides a thorough investigation of the project effects, but their measurements may not be fully consistent with the changes occurred in reality in relevant project-related factors (demand for space, PRA pricing strategy, utilization of the existing port, market developments, etc.). For this reason, the present evaluation is limited to a qualitative analysis of the MV2 welfare effects. Table II provides an overview of the various impacts, along with their direction and relative magnitude. For the port operator, the net effect is specified on the base of PRA’s internal business case, while for the other effects it is inferred from CPB (2001a, 2001b).

Conclusions about MV2

The possibility to create new space within the Rotterdam port complex is expected to bring about multiple benefits both locally and nationally including:

- Better positioning in the market. By expanding and developing industrial and transport facilities, PRA is able to overcome space shortages and realize profitable investments, seize the opportunities from future market developments in sea transport, and gain strategic advantages with respect to competing European ports.
Improved logistic and productive services through port capacity expansion. Direct users of the port facilities benefit from more efficient operations, and from avoiding the costs possibly caused by port capacity constraints (congestion, costs of diverting to more distant ports, etc.). Since demand for infrastructure is expected to grow over time, avoiding future bottlenecks through anticipated investment is largely beneficial for the users of the infrastructure.

Outside the port sector, moreover, reclamation-based port development can contribute to broader social welfare by increasing accessibility and competitiveness of the local and national economies. The induced pressure on the hinterland transport network does not necessarily lead to less efficient inland logistic services, as potential bottlenecks can effectively be averted through timely interventions.

Environmental impacts, often considered a critical issue with respect to port expansions policies, also appear less of a concern as reclaiming land means expanding the port seawards, which reduces inhabitants’ exposure to negative effects from port operations while allaying industrial intensification closer to urban and residential areas.

AMAGER STRAND BEACH RECLAMATION PROJECT

Copenhagen, capital city of Denmark, ranks amongst the best world capitals for quality of life. The local government is keen to further enhance the urban living environment and has set ambitious policy plans for the years to come. Guaranteeing accessibility to quality recreational areas is amongst the government’s priorities as leisure activities are seen as a key contributor to residents’ health and well-being (Figure 8).

Amager Strand, a 25-ha beach located about 5 km from Copenhagen city centre along the shores of the Øresund Strait, was originally created in the 1930s. Unfortunately the beach never really attracted people for recreation other than nearby residents. This was primarily because of the beach’s shallow shore face, which resulted in low sand and water quality and the onshore presence of grass roots. Moreover, the beach continuously experienced losses caused by tides and waves from the Øresund. Replenishment works were periodically needed to prevent beach erosion.

In the 1980s, local clubs and associations formed a working committee that developed the idea of a new beach park. Responding to the community’s demand, local politicians finally decided to develop a new beach park in that area.

The beach development project was implemented in 18 months during 2004-2005 at a total cost of €26.9 million. The investment was jointly financed by two municipalities and the Copenhagen Region. A public company, Amager Strandpark I/S, was founded to administer the entire beach area. The project comprised reclamation of a 34-ha island in front of the old beach and the creation of a 35-ha artificial lagoon located between the two components (Figure 9). The beach landscape was designed so as to combine higher beach quality standards (obtained through increasing recreational opportunities, safety, water and sand quality, facilities, accessibility, and so on) with natural sustainability (Mangor et al., 2011). As for the latter, littoral transport is minimised through creation of a stable beach profile and the installation of terminal structures, which make replenishments no longer necessary for preventing beach erosion.

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Amager Strand, a 25-ha beach located about 5 km from Copenhagen city centre along the shores of the Øresund Strait, was originally created in the 1930s. Unfortunately the beach never really attracted people for recreation other than nearby residents. This was primarily because of the beach’s shallow shore face, which resulted in low sand and water quality and the onshore presence of grass roots. Moreover, the beach continuously experienced losses caused by tides and waves from the Øresund. Replenishment works were periodically needed to prevent beach erosion.

In the 1980s, local clubs and associations formed a working committee that developed the idea of a new beach park. Responding to the community’s demand, local politicians finally decided to develop a new beach park in that area.

The beach development project was implemented in 18 months during 2004-2005 at a total cost of €26.9 million. The investment was jointly financed by two municipalities and the Copenhagen Region. A public company, Amager Strandpark I/S, was founded to administer the entire beach area. The project comprised reclamation of a 34-ha island in front of the old beach and the creation of a 35-ha artificial lagoon located between the two components (Figure 9). The beach landscape was designed so as to combine higher beach quality standards (obtained through increasing recreational opportunities, safety, water and sand quality, facilities, accessibility, and so on) with natural sustainability (Mangor et al., 2011). As for the latter, littoral transport is minimised through creation of a stable beach profile and the installation of terminal structures, which make replenishments no longer necessary for preventing beach erosion.
Overall, Amager Beach Park now encompasses the old beach (approx. 25 ha), a new artificial island and the lagoon. With the construction of the artificial island, about 3.5 km of additional quality sandy beach became available to visitors. Since its implementation, the project has been well received by local dwellers. The beach company reckons that the flow of visitors has increased more than 1 million units per year, making Amager Strand the first beach in Copenhagen for a great number of visitors. The new area (the island plus the lagoon) offers numerous recreational opportunities to visitors such as fishing, swimming/diving, rowing and kayaking, kite/wind surfers, skating, jogging and various ball games (Figure 10).

Both high water quality standards and safe swimming are ensured by a moderate wave and tidal exposure and by sufficiently deep water around the reclaimed area. A natural beach environment was reproduced on the island through the creation of winding paths, broad sandy beaches and low dunes. Moreover, the island is equipped with recreational and service facilities including: a small marina, bathing structures, free parking space, lifeguards, restrooms and showers, picnic sites, and services such as restaurants, cafes and mobile vendors. As it was designed, the new beach does not provide flood protection and ecosystem services locally.

**Financial Analysis**

From a financial point of view, the beach reclamation project involves only public monies. Local government directly financed the construction of the park. Net of the revenues collected through concessions and rents, total operating costs amount on average to €1.07 million per year. By integrating the stream of investment and net operating costs with the costs avoided by not needing sand replenishment (ca. €13,400 spent every two years), the cash-flow can be easily discounted to determine the (financial) NPV of the project (Figure 11).

An intermediate value for the discount rate (5%) is chosen based on Danish standards (Doubgaard, 2004), while the time horizon is set to 30 years following the EC (2008) guidelines for CBA of parks and forests. Financial returns are of course not to be expected from the project, given that access is free for visitors. As is normally the case for public goods, tax revenues are instead used by local governments for developing and maintaining the beach park. The financial burden for the community is reflected by a negative NPV of around €43 million.

**Socio-economic analysis (CBA)**

The economic analysis looks into all the effects Amager Strand generates on the society, which essentially comprises the inhabitants of Greater Copenhagen. Beyond the monetary transactions that were examined in the financial analysis, the beach project contributes to local welfare by providing recreational services to visitors (users). The resulting use-values are related to the consumption of “goods” such as open space, natural landscape, outdoor recreational activities and so on. Such goods do not have a market value, so a non-priced effect is involved here (Table III).

Non-users (third parties) could also enjoy from the presence of the new beach in their city/region even without visiting it. Residents may derive satisfaction for example from the mere possibility of visiting the park that is acquired by themselves (option value), by others (altruism), and by future generations (bequest value), see Pearce et al. (2006). The area surrounding the beach may be positively influenced as well, e.g., because of the impact the beach development has on house values. Lundhede et al. (2013) have found that a standard house located closer to Amager Strand is worth on average around 25% more than other properties in the same district.

Indirect effects from the beach reclamation seem to be rather inconsistent, since the

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**Input data for NPV calculation**

<table>
<thead>
<tr>
<th>COSTS</th>
<th>BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment costs</td>
<td>Avoided replenishment (every 2 years)</td>
</tr>
<tr>
<td>Net operating costs AmagerStrand I/S per year</td>
<td>Average N. of visitors per year</td>
</tr>
<tr>
<td></td>
<td>Average Consumer Surplus per visit</td>
</tr>
<tr>
<td></td>
<td>Average Consumer Surplus per year</td>
</tr>
<tr>
<td>Investment horizon</td>
<td>Investment horizon</td>
</tr>
<tr>
<td>Discount rate</td>
<td>Investment horizon</td>
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<td></td>
<td>Discount rate</td>
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<tr>
<td></td>
<td>Discount rate</td>
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</tbody>
</table>

Figure 11. Financial vs. socio-economic Net Present Value (in euros) of Amager Strandpark beach reclamation project (CS=4, discount rate 5%). (Source: Amager Strandpark I/S (costs inputs and number of visitors).
results when the welfare benefits for visitors are added to the financial components. Given the quality of the beach and of its facilities, the visit-CS value chosen is relatively low compared to the €2-37 reference range previously indicated. To derive more meaningful conclusion on this case study, however, the NPV calculation is repeated using different values of both the discount rate and the individual consumer surplus per visit (Figures 12 and 13). Apart from the various observations that can be made on the elasticity of the NPV, an important conclusion emerging from the sensitivity analysis is that the NPV results positive in all scenarios but the one with a very low visit-CS. Therefore, the conclusion of a positive socio-economic impact of the beach development project appears robust to changes in relevant parameters.

Conclusions about Amager
This case study well exemplifies a situation when a reclamation-based investment project contributes to enhancing quality of life in an urban situation. In addition, other interesting issues can be deduced from the evaluation of this case study:

• Project effects can be highly relevant for society even though they do not involve market transactions.
• Non-market valuation methods are key instruments for a meaningful evaluation of the welfare impacts of public goods such as recreational resources and green infrastructures.
• When non-priced, unquantifiable effects are substantial, investments may have benefits for society even if they are not financially sustainable. In such cases, governments are called upon to ensure an optimal provision

Table III. Socio-Economic Effects of Amager Strandpark.

<table>
<thead>
<tr>
<th>Welfare effects</th>
<th>Sign/magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct effects</strong></td>
<td></td>
</tr>
<tr>
<td>• Operator</td>
<td>Negative profit for beach administrator – –</td>
</tr>
<tr>
<td>(Amager Strandpark I/S)</td>
<td></td>
</tr>
<tr>
<td>• Users</td>
<td>Welfare surplus from consumption of recreational services. ++</td>
</tr>
<tr>
<td>• Third parties</td>
<td>Non-use values enjoyed by local residents (option value, altruism, bequest value). +</td>
</tr>
<tr>
<td><strong>Indirect effects</strong></td>
<td>Not relevant</td>
</tr>
</tbody>
</table>
of public goods through a direct involvement in the investment funding.

- As demonstrated with the sensitivity analysis, the assumptions made on critical factors strongly influence the final results of the appraisal. A thorough examination of the most relevant aspects concerning an investment project is therefore necessary.

REFERENCES


CONCLUSIONS

The article discusses how CBA methodologies can be useful for evaluating reclamation projects. The main expectation was to contribute to a more appropriate assessment of the socio-economic performance of reclamation projects by using CBA.

The article has shown that investing in reclamation can be socially beneficial even if the project generates meagre financial returns. The benefits for users, economic spill-overs, as well as the impact on the local quality of life, support the implementation of the project more than simply the dividends that may be provided to private investors. These effects must be carefully considered when assessing the economic legitimacy of reclamation projects.

The socio-economic benefits of reclamation projects are broadly speaking, a strategic instrument for coastal development because land reclamation offers the possibility to undertake spatial plans potentially anywhere within congested coastal regions. By solving the problem of space scarcity, port cities can unlock local investments and exploit opportunities for unleashing strong economic potentials, creating sustainable urban systems, and increasing well-being and quality of life for the broader society.

Through land reclamation along the coast important interventions can be realised to support existing infrastructures, whilst avoiding the drawbacks that could instead result from expansion plans made on land in more peripheral areas. The increase in accessibility and competitiveness achievable through infrastructure developments can drive new investments, enhance the local business environment, and prepare the ground for further sectorial specialisation, technological innovations, and diffusion of specific skills and knowledge across companies and workers.

The flexibility of land reclamation projects at the coast offers great opportunities to urban planners to enhance the quality of the environment of the served population. New seafront land can be created in the proximity of the city core or of industrial areas where connections to existing transport networks and urban agglomerations are easier to achieve. Disregarding environmental and other external effects may cause underestimation of the value of land reclamation, with the risk that investors prefer cheaper but less sustainable projects on existing land.

All in all, environmental, strategic and other social effects deserve particular attention when considering reclamation projects. The existence of beneficial impacts on society, moreover, justifies an active role of the governments.