DEPARTMENT OF INTERNATIONAL AND EUROPEAN ECONOMIC STUDIES

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

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Working Paper Series

20-21

May 2020

Chapter 4
Social acceptance and socioeconomic effects of Multi-Use Offshore Developments: Theory and Applications in MERMAID and TROPOS projects

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Abstract

This chapter[12] studies the social acceptance and socio-economic effects associated with the development of multi-use offshore platforms, using a theoretical concept in Taiwan as the relevant case-study. We use a face-to-face surveys together with in-depth interviews with local people and tourists who are currently or will be potentially affected by offshore developments on Liuqiu Island. A choice experiment is deployed to assess the ecosystem services and non-market effects of the platform. The social costs and benefits analysis are adopted to synthesize both market and non-market effects of the platform. The study finds a generally high support for the platform among tourists. The concern mainly focuses on the uncertain environmental impacts and effects on local fishery industry. Neither locals nor tourists view the energy hub which generates most income and jobs as a very attractive option. The Green & Blue concept shows a high environmental nonmarket benefit which amount to 618 million $NT. However, the high investment cost over weighs the positive GDP and environmental gain when comparing the social benefits with investment costs.

Key words: offshore platform, multi-use, social acceptance, ecosystem services, choice experiment, social costs and benefits

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[12] This work has received funding from the European Union's 7th Framework Program under grant agreement N° 288710 and N° 288192

4.1 Introduction

With increasing population growth and intensified competition for space close to the ocean, exploration of the ocean space is attracting new interests, particularly with the development of new technologies (IPCC 2007, Mazor et al. 2014, Wyllie et al. 2017). Sustainable use of ocean is important to reduce the present pressure of human exploitation and obtain enhanced and sustained ecosystem services from ocean (Harris and Tuhumwire 2016). By introducing new technologies and concepts, such as the development of new multi-use offshore platforms, it will be possible to utilise the ocean space in a sustainable manner for future 'blue growth'. The multiple use of offshore platforms means various functions and productive activities co-existing in the same area, such as shipping, aquaculture, renewable energy and tourism (TROPOS 2015). The various functions are connected to each other in a sustainable way so as to minimize the impact on each other and to maximize the synergies between them.

Many studies recognized that visual impacts of large offshore constructions affect public acceptance of such constructions (Bishop and Miller 2007; Tsoutsos and Tsouchlaraki 2009; Ladenburg 2008). There are also significant negative welfare effects in terms of environmental degradation from such constructions as highlighted for example in Álvarez-Farizo et al. (2002) and Busch et al.(2011). The development of multi-use platforms is not only technically challenging and financially costly, it also raises various social and economic issues. In terms of benefits, the platform may bring more income and increase employment for local areas during the construction phase. There are further benefits due to the production of renewable energy and farmed fishes, and promotion of tourism that is environment friendly. On the other hand, the construction of such platforms may negatively affect local fauna, disturb existing fishing grounds and affect seascape amenities (Lu et al. 2014). Therefore, it is also important to identify the potential socio- economic effects including both market and non-market effects as well as the individuals whose welfare is likely to be affected before the concept of such platform is put into implementation (Just et al 2005; Bockstael and Freeman 2005; Clinch and Murphy 2001). Like other offshore investments, the ultimate success of such concepts will depend on the acceptance and support from local communities and various interest groups (Haggett 2011, Rudolph 2014, Batel et al. 2013, Devine-Wright 2005 and Roberts and Boucher 2013).

The paper aims to study the social acceptance and socio-economic effects associated with the development of such offshore platforms produced for the Liuqiu Island, Taiwan. Social acceptance analysis combines a face-to-face survey together with in-depth interviews questions with local people and tourists who are currently or will be potentially affected by offshore developments on Liuqiu Island. A choice experiment (CE) is deployed to elicit stakeholder preferences in relation to the different platform designs, assessing the ecosystem services and non-market effects of the platform. To the authors' knowledge, this is the first non-market valuation of multi-use platform and the first one using a CE in this context. The paper then proceeds to use the social costs and benefits analysis to synthesize both market and non-market effects of the platform.

As such offshore investments are likely to become more common because of increased pressures from growing populations and on coastal spaces, this paper provides a guideline and examples for assessing the socioeconomic effects of such investments. During the social acceptance interview, it was found that in general there was generally high support for the platform. The interviewees mainly concern the uncertain environmental impacts and the effects on local fishery industry. When tourists were presented various modules of the platform in detail, a majority of tourists prefer the platform with renewable energy and leisure facility. Neither locals nor tourists view the energy hub which generates most income and jobs as a very attractive option. The Green & Blue concept shows a high environmental nonmarket benefit which estimated at 618 million $NT. However, the high investment cost over weighs the positive GDP and environmental gain when comparing the social benefits with investment costs.

The paper is structured as the follows. Section 2 briefly details the MUOP concept and its location. Section 3 outlines the methodologies used to study the social acceptance and socio-economic effects of the platform. Section 4 then outlines the key findings in terms of the role of new technologies, the importance of understanding key issues in the local context, and the role of benefits, communication and participation. As well as the ecosystem service values from choice experiments and the net present socioeconomic value for constructing such a platform in the case of Taiwan.

4.2 New offshore platforms: the TROPOS platform in Taiwan

This paper reports on some of the results on the TROPOS project (http://www.tropossplatform.eu/), which is part of EU FP7 programme 'Ocean of Tomorrow', 'OCEAN 2011.1 – Multi-use offshore platforms' (MUOP), exploring a range of aspects of the development of such platforms. The project focuses on the development of a floating modular multi-use platform system for use in deep waters, with locations in Crete (Greece), Gran Canaria (Spain) and Taiwan (Quevedo et al. 2013). The intention is that the flexible multi-use platform system will be able to integrate a range of functions from the Transport, Energy, Aquaculture and Leisure sectors (named as TEAL components). The platform aims to reduce land use pressure and make use of the ocean space in a more sustainable manner (Quevedo et al. 2013). The concepts represent a new way to develop the offshore, combining a range of uses, and with the potential to address a range of sustainability related issues. The developed TROPOS platform concepts are all composed of a central unit (CU), different modules, which are integrated into the central unit, and satellite units connected via subsea cables. The platforms are designed around the concept of 'Green & Blue', which means combining the generation of clean energy with the use of biological ocean resources.

One Green & Blue platform scenario is set of off Liuqiu Island, which is located southwest of Taiwan's main island. The area of Liuqiu Island is about 6.8 square kilometres, and most of the islanders make their living by fishing. Recently, the island has become one of the major tourist destinations, and increasingly, local incomes rely on the tourism industry (Chen et al, 2015). Figure 1 shows the island and villages where surveys were conducted.

The platform concept combines offshore fish and algae aquaculture with OTEC (Ocean Thermal Energy Conversion) for energy supply. All of the platform's energy needs will be provided by renewable energy modules. Leisure facilities are also included to accommodate tourists. A total of 5 modules and a satellite type will be designed to fulfil this objective. The components and services included in this platform concept are summarised in Table 1.

Aquaculture facilities include fish and algae production as two satellite units. Aquaculture production has the following potential environmental impacts:
a) Solid and liquid wastes have a major effect on water and sediment quality, benthos, fish and turtles, marine mammals and humans
b) Noise and vibrations that affect fish and turtles and marine mammals, the mooring will significantly affect sediment dynamics

c) Artificial lighting of the fish farm units poses a major impact on marine mammals, birds and bats, and fish and turtles
d) Escape of fish from the fish cages and the introduction of alien species pose a major impact for plankton, benthos, fish, turtles and potentially the entire ecosystem

The concept is planned to include a floating Closed-Cycle OTEC plant. Due to its rather heavy structure and its autonomy, the OTEC plant is considered as a satellite. OTEC produces constant, base-load electricity in a turbo-generator that is driven by the evaporation/expansion of the working fluid ammonia in a closed circuit. There is significant potential to combine OTEC with aquaculture. The OTEC plant is expected to have moderate effects on the environment, although the stressor heat energy may have an effect on water temperature and the pelagic flora and fauna. Physical stressors owing to potential changes in seawater salinity and water column stratification may also affect the pelagic flora and fauna.

Leisure facilities include accommodation and the following facilities: restaurant, a sky observation lounge, a garden and a store. Solid and liquid wastes coming from the daily operations of the leisure modules onboard a Central Unit will most likely have a major effect on water and sediment quality, benthos, fish and turtles, marine mammals and humans. To reduce or avoid potential negative impacts of the TROPOS elements on the environment, appropriate mitigation measures are required; in particular for impacts expected to be of major or critical significance for the ecosystem and its receptors.

MODULES	COMPONENTS/SERVICES	Modules
Fish Aquaculture	Fish Aquaculture parts of the 30 Satellite Units	Fish Aquaculture Module (on CU, operation and control)
Algae Aquaculture	Algae Aquaculture parts of the 30 Satellite Units	Algae Aquaculture Module (on CU, operation and control)
	Bio-refinery (on CU) Storage	Storage (on CU)
Processing Plant (CU)		Processing, packaging, freezing
OTEC Plant	Energy (electricity) generation and clean, deep-water supply	
Accommodation	Hotels for tourists and related services	Accommodation for aquaculture staff

Table 1: Components and services of the Green & Blue platform scenario off Liuqiu Island (Chen et al. 2015)

4.3 The methodologies used

4.3.1. The methodology for assessing social acceptance

An integrated multi-use offshore development is a future possibility for the Island, however the spatial overlapping with traditional fishing practices and other usages may cause conflict. Evidence shows that local awareness, support, and involvement are key elements for developing marine renewable energy (Haggett, 2011; Rudolph, 2014). Indeed, people's acceptance of a new development is decisive for a

project's implementation (Roberts and Boucher, 2013). The consideration of social acceptance and local knowledge may thus lead to more competent and well-founded planning decisions.
Social acceptance is a key concept in literature on human geography, sociology, and other research on the development of new infrastructure projects (se Batel et al, 2013; Devine-Wright, 2005). In their seminal paper on this concept, Wustenhagen et al (2007) describe the importance of social acceptance, and that it needs to be urgently considered during the implementation of new policies and projects (2007:2683). Understanding social acceptance means exploring the conditions that determine the effective support (and opposition) that any applications receive, and Wustenhagen et al (2007) determine that it consists of inter-related 'socio-political acceptance', 'community acceptance' and 'market acceptance'.

In this paper, we address in particular the concept of 'community acceptance', which refers to the "specific acceptance of siting decisions and projects by local stakeholders, particularly residents and local authorities". (Wustenhagen et al. 2007:2685). Acceptance is determined by a range of interconnected and contextual factors, some of which will relate to the project itself (specifics such as a visual impact - see Haggett 2008); some will relate to the location in which it is planned (such as impact on local wildlife or the local economy - see Rudolph 2014); and some will relate to the process through which the project is being developed (perceived fairness of decision-making processes, the role of public engagement - see Gross 2007; Haggett 2010; Rudolph et al. 2015). All of this matters for a variety of reasons. As Yearley et al (2003) document, understanding social acceptance may be important pragmatically – a project is more likely to be consented if it has public support (Wolsink 2007). But people also may be viewed as citizens who should be involved and engaged about projects that affect them (Bell et al, 2005); and asking local people about their local area can help to improve a project by accessing detailed and rich local knowledge and understanding (Creamer 2015; Aitken 2009; Wynne 2006).

Social acceptance is therefore a critical issue with the development of any new project; and we suggest that this is particularly the case with a very new and novel technological innovation such as a new offshore platform. It is important to understand the views of 'the community' – in Wustenhagen et al's terminology – this means local people, key stakeholders, to understand the key local issues and how they might affect perceptions of the new project (Aitken et al 2014; Pieczka and Escobar 2013).

In this research, social acceptance of the multi-use offshore platform was investigated using a multi-method approach (Teddlie & Tashakkori 2011), which was used to capture a range of different responses to this new concept. The intent was to meaningfully capture the key concerns of stakeholders and also to collect a broader sample of information from local people from which generalizable trends could be observed. Understanding the local context is key; and as the platform is being designed in a location dependant on tourism, it was also important to survey tourists to the area. Drawing on best practice from the research methods literature (for example, Winchester 1999), The approach used here therefore comprised a face-to-face survey with local people and tourists on Liuqiu Island, as well as in-depth interviews with particular stakeholders who are currently or will be potentially affected by offshore developments.

The first part of the multi-method framework applied to reach a wide range of participants, was a multiple-choice questionnaire. A large-scale survey was used to give an indicative overview of how the offshore platform is perceived. The central principle of such quantitative studies on social acceptance is to measure and describe relationships and correlations among variables and factors that influence people's acceptance of offshore developments (Roberts & Boucher 2013). In addition, to be able to explore the range of perceptions and potential impacts of the platform in-depth, a qualitative interview was used to obtain first-hand information on social realities as they are constructed and presented by various actors, following the approaches of Silverman (2004) and Sin (2003). Rather than solely obtaining structured and quantitative evidence of social acceptance, the qualitative interview can assist in gaining access to reasons behind the different supportive or opposing positions towards the proposed offshore platform (Fielding 2007). Such a research strategy uses people's detailed accounts as a starting point to make sense of the meanings and interpretations, the motives and intentions, and arguments that people articulate verbally, and that guide and give evidence of their attitudes and behaviour (Blaikie 2010).

The applied interview approach comprised semi-structured interviews, which allowed for some flexibility for the interviewer as well as the interviewee (Fielding 2007). Questions for the interviews were prepared prior to the interview and listed in an interview guide to organise and group themes, issues and questions (May 2007; Fielding 2007). The interview questions made use of insights from previous research on factors likely to determine the acceptance of offshore renewables as discussed above, but also factors relevant to local particularities that may be the object of impacts and concern for people. The sampling of interviewees drew on the suggestions made by previous research on offshore renewables, but also on the findings of the preceding survey (May 2007). Relevant stakeholder groups who may be affected by offshore platforms involve the fishing and shipping community, local leisure industry, coastal communities, local and regional governments, local businesses and tourism as well as other marine users.

4.3.2. The methodology used for assessing the socioeconomic effects of the platform

Valuing Ecosystem Services

A key element in the socio-economic methodology used in the paper is the valuation of ecosystem services to study the impacts of Multi-Use Offshore Platforms on the environment and the populations targeted in the TROPOS project. Ecosystem services are widely understood in the literature as the different benefits that humans obtain, directly or indirectly, from natural ecosystems (for example, Costanza *et al.* 1997, Daily 1997, de Groot 2002, MEA 2005.). The ecosystem services provided by the oceans can be grouped into four main categories: a) provisioning services such as food and water, b) regulating services such as climate mitigation, c) supporting services such as seabed sediment formation and nutrient cycling, and d) cultural services such as recreational, spiritual, and other non-material services (MEA 2005). The Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC) establishes that the economic valuation of offshore projects should follow an ecosystem services approach. It is expected that the multiple tasks that will be conducted in the platforms (e.g. energy production, aquaculture and platform related transport and logistics) will have an impact on marine ecosystem services, directly or indirectly. The expected benefits created by platforms include the provisioning services, regulating services and cultural services. They include the production of sustainable food and energy, touristic activities, direct and indirect employment, and several environmental benefits (e.g. improved water quality near coast, climate change mitigation). On the other hand, there are potential negative effects on supporting services. They include the risk of affecting the seabed, the risk to jeopardise populations of fish, mammals and birds in the area. Thus, it is very important to identify and value the different impacts that the proposed structures will have on the ecosystem services. This will help to ensure that all the activities, linked to the design and implementation of the projects, are regulated. Ultimately, the valuation of the ecosystem services will provide useful information to policy makers that can be used to decide whether the project is appropriate for the preservation of a sustainable marine environment and the augmentation of the overall social welfare (Koundouri *et al.* 2016).

A Choice Experiment (CE) was conducted in order to identify tourists' and residents' preferences for two different platform designs. The CE method is part of the Total Economic Value framework, which is a standard theoretical approach used for capturing and describing the benefits derived from the different ecosystem services (Defra, 2007). Stated preference methods use structured questionnaires in order to identify the individuals' preferences for a given change in a natural resource or environmental attribute (Champ et al. 2003). Lancaster (1966) explains that any good can be described in terms of its attributes and their levels. Experimental design theory was used to generate different profiles of the platforms in terms of its attributes and their levels. These profiles were then assembled in choice sets and presented to the respondents. Respondents are asked to state their preferences. In this CE, individuals are assumed to choose the design that provides them with the highest utility. The utility function is then used to estimate welfare indicators (willingness to pay –WTP- or willingness to accept -WTA-) based on the levels of attributes (Bennett and Adamowicz, 2001; Birol and Koundouri, 2008). In this case, the welfare indicators can be understood as the value of changes on the ecosystem services derived from the platform.

The Random Utility theory is the basis for the CE developed in this document, where the utility of a given platform alternative for an individual is a function of the attributes of the platform alternative and of individual socioeconomic background features. A second utility relation links the probability of an alternative being chosen to the utility of each alternative. That is, individuals are assumed to choose the alternative yielding the highest utility. An econometric analysis is then conducted using an ordinal logistic model in order to elicit the stakeholder's preferences for different platform designs. The functional forms can be found Chen et al (2015). The utility function is then used to estimate welfare indicators (willingness to pay –WTP- and willingness to accept -WTA-) based on the levels of attributes (Bennett and Adamowicz, 2001; Birol and Koundouri, 2008). In our case the welfare indicators tell the value of ecosystem services change affected by the platform.

Social Cost Benefit Analysis (SCBA)

The Social Cost Benefit Analysis (SCBA) is a technique that assesses the monetary social costs and benefits of an investment project over a time period, in comparison to a well-defined baseline alternative, in our case the status quo situation. In this way, the social costs and benefits of a platform are evaluated and compared, and the long-run economic efficiency of implementing the project of platform is assessed. The methodology pays close attention to both the financial and socio-economic assessment of the project. The financial assessment includes the estimation of financial costs of the investment, the estimation of project development costs, operation and maintenance costs, as well as training costs. The socio-economic assessment takes into account all the direct, indirect and induced economic benefits in terms of regional output, income and employment (i.e. market goods), as well as the benefits from positive externalities (i.e. non-market goods) on the environment (through the valuation of the ecosystem services). A project is deemed to be profitable if total social benefits exceed total social costs. Due to the project's expected long-run impacts on the local economy and ecology, its sustainability is to be examined by using the SCBA. The net present value (NPV) or the social net present value (SNPV) of the project is to be estimated using different discount rate schemes (Birol et al., 2010). The NPV/ SNPV results reveal whether the net social benefits generated by the investment project of MUOPs is positive and significant well into the future.

4.4 Data collection and description

4.4.1 Social acceptance and choice experiment survey

Survey designs, data collection process and data description are detailed in the TROPOS report, Chen et al. (2015). Here we reiterate the data to brief the readers.

The survey for both social acceptance and choice experiment include a pilot and a final survey. The pilot surveys were used to test the feasibility of the questionnaires before the final full survey. Both the pilot and full survey for the two were combined together due to limited time and resource of the project. The pilot surveys were conducted on Liuqiu Island between 31st August and 2nd September 2014.

Survey design: Social acceptance

For the social acceptance part, qualitative questions were added after the pre-structured questionnaire due to limited time and resources. The questionnaires include questions stakeholders' viewpoints on potential social effects of offshore aquaculture, on existing fishing industry, OTEC and tourism. The potential social effects include the effects on health, quality of living environment, economic and material well-being, culture, family and community, and institutional legal political equality.

Survey design: Choice experiment

The choice experiment survey follows the standard five steps, that is, selecting desired attributes, defining levels, choosing the experimental design, and constructing choice cards and measuring the preferences. This part of the survey contains questions on respondents' attitudes, 12 choice sets of different levels of attributes and follow up questions. The attributes describe the potential impacts of the platform on employment and the environment as well as two levels of mitigation and conservation options. The two experimental designs are design 1 with only aquaculture facilities and design 2 with aquaculture facilities, renewable energy and leisure facilities (see Annex). There are two environmental impact mitigation levels, acceptable level and optimal level. The acceptable level means the mitigation options will have an acceptable reduction on environmental impacts. The optimal level means the mitigation options will have optimal mitigation options and conservation programs and high visitor satisfaction. For residents, a local tax increase (absolute value per year) is proposed as a payment vehicle. It takes the form of a willingness to pay to avoid environmental damage. This attribute has five levels: a) 0 euros per year (status quo); b) 10 euros per year; c) 20 euros per year; d) 30 euros per year; e) 40 euros per year. For tourists, the payment vehicle is a daily tourist tax that is, an increase of the cost of their holiday in Liuqiu Island per day. The levels for tourist tax were set to: a) 0 euros per day (status quo); b) 2 euros per day; c) 4 euros per day; d) 6 euros per day and e) 8 euros per day.

Data description

Sample sizes for pilot and full survey are presented in

Table 2: Sample size for social acceptance in pilot and final full survey (Chen et al. 2015)

As all the participants fulfilled social acceptance part but not all the participants finished the choice experiment part. Therefore, the sample size of the pilot survey for social acceptance study is different from that of the choice experiment study. That is, there are 21 local residents and 28 tourists for social acceptance study and 9 local residents and 11 tourists for choice experiment study.

Respondents from the pilot survey complained that the questions on choice modelling was too complicated and too lengthy. The questionnaires used in the final full survey was thus modified for easier completion. Modifications include a question on annual income and adding a map with administrative boundaries of Liuqiu Island to facilitate respondents to link their marine activities to the platform. Both local residents and tourists were approached randomly in the full survey.

The full survey was carried out in a face-to-face manner between 8th and 16th November on the island. There were 152 participants in total with 118 tourists and 34 residents. Each of the interviewees were shown 12 choice cards and were asked to do the following ranking: 1st=most preferred, 2nd=residual, 3rd=least preferred. The sample size of tourists and residents were arranged in proportion to the size of local population and average monthly tourists in 2013 as required by the choice experiment study. The respondents cover eight villages and five major scenic areas (
Table 3). The number of respondents from each village was decided according to the population distribution of Liuqiu Island in 2014.

	Pilot Survey		Final Survey
	Social acceptance	Choice experiment	
Residents	22	9	34
Tourists	26	11	118
Total	48	20	152

Table 2: Sample size for social acceptance in pilot and final full survey (Chen et al. 2015)

Village	Population	Proportion	Survey	
			Optimal number	Actual number
Shangfu	1926	16%	5	5
Dafu	1902	16%	5	5
Chungfu	1364	11%	4	4
Tienfu	1213	10%	4	4
Benfu	2402	20%	7	7
Sanfu	897	7%	3	2
Nanfu	1333	11%	3	3
Yufu	1114	9%	3	4
Total	12151	100%	34	34

Table 3: Sample distribution among villages (Chen et al. 2015)

4.4.2 Data on social costs and benefits

Table 4 shows the CAPEX, OPEX, the GDP impacts, the approximated employment effects[13] and the total multiplier effects of the investments for the Green & Blue concept of Taiwan. The data are cited from TROPOS (2014) and are calculated by using regional input and output model. The table shows that the GDP impact for the leisure module is the lowest among the three modules. The GDP impact for energy hub is the highest. (TROPOS, 2014).

The data for calculating social costs and benefits include the market benefits (i.e. effects on GDP[14]) when constructing such a platform and during operational phase, the non-market benefits i.e. environmental benefits, investment cost (CAPEX) and operational cost (OPEX). The interest rate used in the baseline study is set at 4% and life span for the project is 20 years. Table 5 provides the variable explanation and values used in the analysis.

	Cost (million $NT)		GDP impacts (million $NT)	Employment impact (FTE)	Multiplier effect Per annum
Leisure	CAPEX	1,767	670	547	1.91
	OPEX (annual)	179	189	104	2.19
Aquaculture	CAPEX	2,759,21	955	753	1.83
	OPEX (annual)	1,565	672	580	1.85
Energy	CAPEX	3,198	1,118	878	1.95
	OPEX (annual)	1,448	542	391	1.72
Total monetary value	CAPEX	7,724	2,743	2,178	-
	OPEX (annual)	3,192	1,403	1,075	-

Table 4: GDP impacts and the total multiplier effects of CAPEX and OPEX for the Green & Blue concept in Taiwan

Variable			**Unit**	**Value for each variable**	**Source**
B_t	Market benefit	GDP impact (OPEX aquaculture + leisure + energy)	Million $NT	1403	TROPOS (2014)
	Environmental benefit/Non-market benefit	Aquaculture +leisure + energy	Million $NT	618.25	Choice experiment estimates
C_t		OPEX (aquaculture +leisure + energy)	Million $NT	3192	TROPOS (2014)
R	Interest rate			0.04	
T	Project life span		Year	20	
I	CAPEX	Aquaculture + leisure + energy	Million $NT	7724	TROPOS (2014)

[13]The employment effect is estimated according to contribution of GDP to employment in Gran Canaria. The assumption is made due to lack of data in Taiwan.
[14] The GDP effects of CAPEX and OPEX are calculated by using regional input and output model. Details refer to TROPOS (2014).

GDP_{impact}	GDP impact of CAPEX	Aquaculture + leisure + energy	Million $NT	2743	TROPOS (2014)

Table 5: Variables explanation and values used in the social cost and benefit analysis

4.5 Results for a TROPOS multi-use platform in Taiwan

4.5.1 Social acceptance

A key finding from data collection was a general lack of awareness about the proposed offshore platform project. The high degree of unawareness, particularly among the local population and tourists may indicate poor project public relations activities, and points to the need to improve local stakeholder involvement in the project planning. Awareness raising can help gain support and legitimise the project, to address potential concerns, and to embed the project in the local context.

Despite the relative unawareness of the project[15], the data indicate that the majority of participants initially support such a project, or they stated that they had not formed an opinion yet. 40% of residents and 73% of tourists choose more likely to support the project when being confronted with the proposal of the Green & Blue concept.

Despite the general acceptance of such a project, a number of concerns were raised. These concerns were predominantly related to environmental impacts and unclear effects on local fishing and fish processing industries. Key concerns seem to be based on the concept and use of the platform, which overlaps with and may thus destabilise existing industries. Other issues that challenge the acceptance of the project include uncertain environmental impacts and adverse effects caused by the construction of the platform.

Negative impacts are contrasted with likely benefits for the tourist sector, which is another crucial economic driver for Liuqiu Island. Benefits for tourism businesses are predicted to result in an increase of income and generation of jobs, due to increasing tourist numbers and a boost to the public image of the local area. The generally critical views on potential impacts on the environment and fishing industries seem to have been strengthened by the economic foundation of the area.

Our research has shown that people are mainly concerned with environmental impacts and potential disruptions to the existing fishing sector. This points to the need for thorough consideration of these concerns in the planning and development process in order to get local citizens on board with the project, to legitimise it and to integrate the platform more effectively in the local context.

4.5.2 Ecosystem services value

The main objective was to identify stakeholder preferences, the willingness to pay, for two different platform designs produced by the TROPOS project for the Liuqiu Island, Taiwan. In the study we only focus on the use value, which includes the direct use value (provision services and cultural services) and the indirect use value (regulating services). We distinguish the local residents and tourists in the choice experiment survey as they have very different preferences. In the paper we only include the results from the tourists as the sample size for local residents is too small to provide valid and robust

[15] The general awareness of the project among stakeholders may be explained by the fact that the project is still at a hypothetical research phase, not at the planning phase.

estimates. Among tourists there are about 41.18% respondents preferred the Status Quo option and 40.96% prefers Design 2 which combines aquaculture, OTEC and leisure facilities. And Design 2 is preferred over Design 1 which include only aquaculture facilities. This may be due to the fact that Design 2 offers leisure facilities that could be used by the tourists.

The results also indicate that the higher the tax, the less likely that the option will be selected as the most preferred by tourists. Table 6 shows the estimated daily willingness to pay per tourist for Design 1 and Design 2 with acceptable environmental mitigation level. If renewable energy and leisure facilities are developed (Design 2) a willingness to pay for a tax per day is estimated to be NT$ 53.66. The total willingness to pay for the whole of Taiwan would amount to NT$ 618.25 million. It should be noted that with only aquaculture facilities are presented (Design 1), tourists require a compensation instead. This compensation was estimated at NT$86.52.

	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
WTP for Design 1	-86.52	33.93	-2.55	0.01	-153.03	-20.00
WTP for Design 2	53.66	23.56	2.28	0.02	7.48	99.85

Table 6: Estimated willingness to pay per tourist per day for Design 1 and Design 2 with acceptable environmental mitigation level

4.5.3. Social Costs and Benefits

In this section we compare the GDP benefits from the investments (capital and operational) and the environmental benefits with the investment costs. By including the non-market value of environmental effects, NPV could be regarded as social net present value, i.e. SNPV. SNPV follows equation (1)

$$SNPV = -I + GDP_{impact} + \sum_{t=1}^{20} (B_t - C_t)/(1+r)^t \qquad (1)$$

Where I is the total monetary capital cost. GDP_{impact} stands for the GDP impact of CAPEX, B_t is the annual social benefit of the platform, C_t is annual social cost of the platform which is equivalent to the financial cost here, t is the life span of the platform and r is the annual interest rate. The project is accepted if SNPV > 0, otherwise it is rejected. When the SNPV is used to decide which project alternative should be chosen, the project with the highest positive SNPV should be preferred.

Table 7 shows the estimation of NPV at an annual base for the multi-functional platform with and without considering the non-market value of environmental effects. As presented in the table, the SNPV values are negative no matter whether the non-market value of environmental effect is included or not, mainly due to the huge investment costs (Chen et al., 2015). Sensitivity analysis is carried out with different discount rate and time span for the project.
Table 7 and Table 9 show the results from sensitivity analysis with 5% interest rate and 70-year time span for the platform respectively. The SNPV are negative in both analyses.

	Green & Blue concept: Aquaculture + OTEC + leisure	
	Without non-market value of environmental effects	With non-market value of environmental effects
SNPV	-29294.41	-20892.21

Table 7 NPV for the platform with aquaculture, OTEC and leisure: with and without non-market value of environmental effects, r=4% and t=20 (unit: million $NT)

	Aquaculture + OTEC + leisure	
	Without WTP for sustainable development	With WTP for sustainable development
SNPV	-27276.21	-19571.46

Table 8: Sensitivity analysis SNPV with WTP for sustainable development r=5% and t=20 (unit: million $NT)

	Aquaculture + OTEC + leisure	
	Without WTP for sustainable development	With WTP for sustainable development
SNPV	-46834.10	-32370.48

Table 9: Sensitivity analysis SNPV with WTP for sustainable development r=4% and t=70 (unit: million $NT)

4.6 Conclusion and discussion

The study found a general lack of awareness about the suggested offshore platform project in Liuqiu Island. Our results highlight the concerns about environmental effects of the platform and the unknown effects on existing industries, such as fishing and fish processing. Other concerns from respondents include questions about who will be responsible for the platform's construction and operation, and most residents were worried the platform could be destroyed by storm waves. Sustainable tourism is regarded as positive by local stakeholders. The findings suggest that current project public relations activities were not proactive and indicate the need to improve involvement of local people and existing industries before the project could potentially be carried out. Sie et al. (2018) uses a Group Model Building approach to improve the stakeholders' understanding of the complex systems and multi-functions of the TROPOS platform. Under the approach the stakeholders are able to discuss and present abstract opinions, expected system behaviours and important factors in a macro-system structures (Sie et al. 2018). Their general findings are in lieu with our results from social acceptance study. They also find for example that stakeholders concern about the negative side of tourism including potential decline of quality of service, traffic jams and negative effects on marine ecological system. The stakeholders also agreed that the platform will enhance fishery ecology nearby the island when the platform uses the integrated multi-trophic aquaculture.

Our findings further show that costs and environment effects are factors that influence stated preferences to a high degree. The presence of energy and leisure facilities moderately affected preferences, and GDP effects and job creation were not deemed very important factors when preferences were stated. Tourists would support the installation of the platform only if renewable energy and leisure facilities were provided. The total willingness to pay for the whole of Taiwan would amount to NT$ 618.25 million. Due to the large investment costs of the platform, the social SNPV is negative, even if the environmental benefits are considered.

In the end we need to point out a couple of issues which need to pay attention but has not mentioned explicitly in our study. The SNPV analysis imply that the GDP impact, capital investment and operating costs as well as the ecosystem service values are additive and mutually exclusive (Munda 1996). As GDP impact is calculated with input-output model and considered only the economic sectors related to platform investments during construction and operation, it does not overlap with the production service and cultural service values obtained from choice experiment. The sectors covered by input-output analysis can be found in TROPOS (2014). Our social cost and benefit study assume that the environmental effects have the same time span as the project. This is mainly due to the fact that we cannot distinguish the regulating service value from value of production and cultural service in choice experiment. In cases when environmental effects last much longer than the project life span, different time span should be used in the social cost and benefit analysis. Positive present value environmental benefits could outweigh the other costs. This is important for environmental goods such as good sea water quality and biodiversity. Finally, our study only focuses on the efficiency. Intra-and inter-generation equity are also import when applying cost benefit analysis to environmental issues (Munda 1996). These are issues we will improve in future research.

Acknowledgments

The research is a collaboration between the TROPOS project (Grant Agreement No. 288192) (www.tropospIatform.eu) and the MERMAID project (Grant Agreement No. 288710) (http://www.mermaidproject.eu/). The TROPOS project and the MERMAIN project were funded by the EU Commission as part of the 7th Framework programme "Oceans of Tomorrow" theme, OCEAN.2011-1: Multi-use Offshore Platforms. Funding for Taiwan partners comes from Ministry of Science and Technology, Taiwan under the EU FP7 Cooperation Project - Modular Multi-Use Deep Water Offshore Platform Harnessing and Servicing Mediterranean, subtropical and Tropical Marine and Maritime Resources (TROPOS). Project Number: 101-2923-I-110-001-MY3. Dr. Osiel González Dávila wishes to acknowledge the support granted by Catedras CONACyT, project 874 "Programa de estudios longitudinales, experimentos y encuestas para el análisis de la pobreza" during the writing up of the final draft. We are grateful for all the participants who involved in the collaboration.

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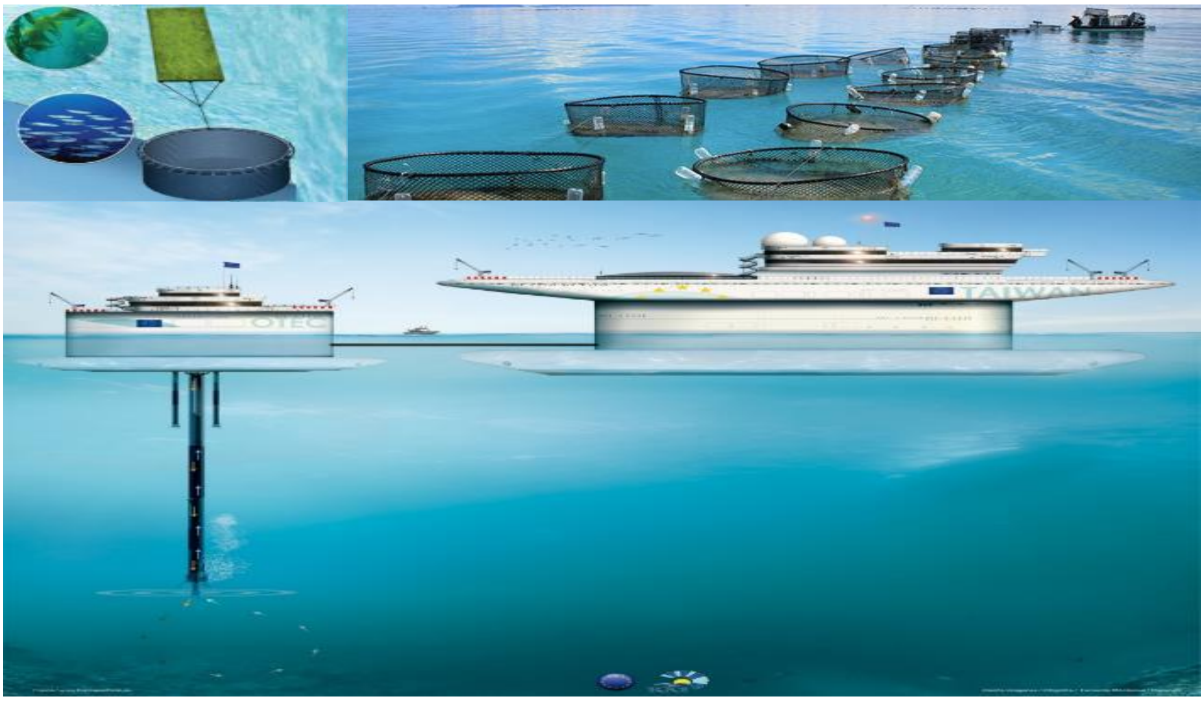
Annex

Design 1. Aquaculture Facilities

Attributes	Description and economic impacts	Environmental Impacts	Levels
Design 1: Aquaculture Facilities (Fish+Algae): Satellite Unit (not inside the platform)	Fish and Algae Aquaculture: 1,333 FTE positions and GDP impact of NT$ 1,660 million (€43.35 million)	**Solid and liquid wastes:** Major effect on water and sediment quality, benthos, fish and turtles, marine mammals and humans **Noise and vibrations:** fish and turtles and marine mammals, the mooring will significantly affect sediment dynamics. **Artificial lighting of the fish farm units:** pose a major impact on marine mammals, birds and bats, and fish and turtles. **Escape of fish from the fish cages and the introduction of alien species:** major impact for plankton, benthos, and fish and turtles	1 Acceptable reduction on environmental impacts 2 Optimal levels of conservation and high visitor satisfaction

Design 2. Aquaculture Facilities + Renewable Energy: OTEC plant + Leisure Facilities



Attributes	Description and economic impacts	Environmental impacts	Mitigation levels	
Design 2: Aquaculture Facilities (Fish+Algae): Satellite Unit (not inside the platform)+ +Renewable Energy: OTEC plant not inside the platform +Leisure Facilities (Accommodation +Food and Beverage)	Fish and Algae Aquaculture: 1,333 FTE positions and GDP impact of NT$ 1,660 million (€43.35 million)	**Solid and liquid wastes:** Major effect on water and sediment quality, benthos, fish and turtles, marine mammals and humans **Noise and vibrations:** fish and turtles and marine mammals, the mooring will significantly affect sediment dynamics. **Artificial lighting of the fish farm units:** pose a major impact on marine mammals, birds and bats, and fish and turtles.	1	Acceptable reduction on environmental impacts
		Escape of fish from the fish cages and the introduction of alien species: major impact for plankton, benthos, and fish and turtles	2	Optimal levels of conservation and high visitor satisfaction
	Renewable Energy + Accommodation, restaurant, sky lounge, garden and store	**Heat energy:** major effect on water temperature and the pelagic flora and fauna. **Solid and liquid wastes:** Major effect on water and sediment quality, benthos, fish and turtles, marine mammals and humans		