

Triple helix interactions for eco-innovation in the developing world: Insights from the Panama Canal watershed[§]

Subtheme: Relevance of the Triple Helix model for sustainable development challenges

Keywords: Eco-innovation, Triple Helix, Panama, science park, ecological modernization, developing country

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Author bio

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Abstract

Eco-innovation encompasses the “creative destruction” of unsustainable patterns of production and consumption. Research on eco-innovation promotion highlights the role of university in supporting industry and government partnerships to achieve sustainability. However, scant literature analyses the role of science parks in promoting eco-innovation. This study uses qualitative data gathered in two units of analysis: Panama Canal Authority and City of Knowledge Science Park. The study examines how Triple Helix interactions have built the regional system of eco-innovation at the Panama Canal. Overall, the research found that the Panamanian national innovation system facilitates eco-innovation by: providing research and development, building competence and financing of innovation processes. The “green maritime route” is an example of institutional eco-innovation promoted by the Panama Canal Authority with insights from consultants, universities and donor agencies. The proximity of the science park to the canal, has hitherto not yielded with the creation of a “green cluster”, which could be a precedent to promote eco-innovations. These findings suggest that, Triple Helix interactions are not institutionalized but take place through adhoc projects. Further, science parks could become mediators in Triple Helix interactions between industry, universities and governments.

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1. Introduction

OECD (2009) defines eco-innovation as:

The implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which, with or without intent, lead to environmental improvements compared to relevant alternatives.

In the small but growing literature on “Eco-innovation”, current discussions focus in two areas: from the one side, on the conceptualization of what makes a sustainable innovation, as opposed to conventional innovation, including setting boundaries among different kinds of Eco-innovation and scales of action (technological and non-technological). The second line of inquiry has focused on how to foster eco-innovations, by explaining and describing the agency of institutions and organizations to promote eco-innovation in consumption and production.

The regional scale is highlighted as a valid scale of study. Actors can establish symbiotic relations while sharing daily experiences, institutions and governance set-ups. Regions can even be part of the integration of the aforesaid Triple Helix of university-industry-government. An example is the windmill sector in northern Denmark (Cooke 2010). In another example, Lehmann, Christensen and Johnson (2010, 54) highlight triple-helix configurations in eco-innovation promotion. Universities contribute with human and intellectual capital in public-private sustainability networks. These authors introduce the term *sustainable regional innovation systems* as: “innovation systems that include significant public-private-(academic) partnerships that address issues of sustainability”.

Sustainable regional innovation system literature is highly focused on developed countries. The aims of this study are threefold: first, to account of eco-innovations at the organizational and institutional level in a developing country. Second, to highlight the role of interactions between actors of the regional system of innovation generating these eco-innovations – with a Triple Helix perspective. And third, to analyze whether drivers for eco-innovation in developed countries are also valid in developing countries. These objectives are made explicit with the following general research questions:

How have Triple Helix set-ups and interactions built the regional system of eco-innovation in the Panama Canal? Which lessons are relevant in the context of developing countries?

The issues of Triple Helix configurations (actors and interactions among them) and the regional scope of study of the innovation system are of high importance for the understanding of how “green” innovations are emerging (Cooke 2010). The intertwined interactions and role played by universities, government and industry, are one of the motors of innovation (Etzkowitz 2008). This research, thus seeks to explore how these issues are complementing to the institutions in order to generate eco-innovations in what can be called a “critical case” of a public company (Panama Canal Authority -ACP), and a science park in the developing world (City of Knowledge). Besides, the interrelations in a Triple Helix configuration with the Panamanian government are included in the analysis. Thus, although it will be further elaborated, the Panama Canal

environmental strategy is unique in the developing world in what concerns watershed protection and greenhouse gas emission (GHG) reduction programs.

To provide an answer to this general research question, it is a must to understand the following sub-questions which will guide the research process:

1. How does the institutional set-up facilitate eco-innovation?
2. How does ACP generate eco-innovation related to its environmental strategies?
3. How is eco-innovation generated at City of Knowledge?
4. Why ACP and City of Knowledge interactions can be a source of eco-innovation?

2. State of the art

This section provides theory background on the relation between eco-innovation promotion and Triple Helix interactions. The role of science parks in the Triple Helix theory is further highlighted.

Geographic implications for the Triple Helix

Closeness and trust building is the basis for increasing interactions among stakeholders of an innovation system. For this reason, regional innovation systems (in which actors are well aware on who is who) may be able to foster specific clusters (Schienstock 2005, 105). This issue has not passed unattended by the Triple Helix theorists. Etzkowitz (2008, 90) states that “Triple Helix technopolis” are regional interconnected webs. These technopolis host interactions among university transfer offices, firms, research centers, clusters and science parks. These interactions are able to come with increasing developments over time. Proximity between industries and research centers spark the creation of science parks and “high-tech conurbations” as the examples of Route 128 and Silicon Valley demonstrate (Etzkowitz and Leydesdorff 2000, 117).

Science parks: closing ties between universities and industry in the Triple Helix

Science parks are also another component of the Triple Helix, and can highlight industry-university interactions. The International Association of Science Parks defines:

A Science Park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions...To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities (IASP, 2010).

This definition implies that industry and universities aim to be linked through science parks. For this reason, they were initially designed for those companies which originated from universities. Having a close location with the university enabled these university’s labs spin-offs to keep relations. In this way, universities expected that employment for students, and funding from the industry could be insured. Similarly, established firms prospected for locations of their R&D departments, in nearby to

universities, in order to enhance firm-university cooperation. Nevertheless, science parks should not be considered as appendixes from either industries or universities, they are autonomous units (Etzkowitz 2008, 98, 101).

According to Mowery and Sampat (2006, 226), the Silicon Valley model initially encouraged all set of replications around the world. The aim was to artificially form a cluster in a given industry/or service and attempt to attract investors and firms to this physical emplacement. However, there is little evidence on the actual impacts of science parks on economy fostering or local development.

The reason behind the previous lack of contribution to local development lies on the firm formation potential which is not fully deployed in conventional science parks. To tackle this drawback some science parks are renewing themselves to include academic elements (as to create their own entrepreneurial universities). Such strategy aims to further contribute to local development by deploying a dynamic of local firm formation, which is opposed to merely attraction of exogenous firms (Etzkowitz 2008, 103).

3. Methodology

As presented in Figure 1, the case study design contains two embedded units of analysis, which are two large organizations: ACP and City of knowledge.

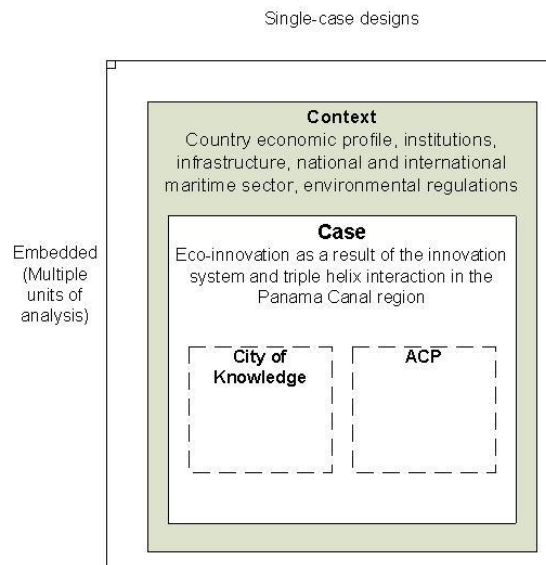


Figure 1- Single case study design with two units of analysis: City of Knowledge and ACP.

Selection of Units of Analysis

The selection of the two units of analysis was theory-based. The Triple Helix theory recalls on how universities-industries-governments are intertwined. Therefore, the case study selection explores Triple Helix interactions at a regional level. ACP could be considered as the lifting industry, as it has the responsibility to manage the canal and to lead the efforts of the watershed protection. Besides, City of Knowledge is the only science park located in the vicinity of the canal.

According to the Triple Helix theory, science parks are the emplacements *par excellence* where linkages between industry and universities can be discovered. Moreover, the presence of research centers, incubators, innovation government agencies

at City of knowledge could imply the possibility to find valuable information about the subject of interest.

Methods of data collection

Three qualitative methods were integrated into the case study protocol: document review, observation and interview. Case study interviewees were selected from the two units of analysis: City of Knowledge and ACP (Appendix 1). Supportive interviews were also conducted as listed in Appendix 2. Semi-structured interview guides were prepared beforehand. Two kinds of triangulation were used the study: between qualitative methods and between sources (Patton 2002).

Interviewees' selection followed two approaches: criterion based and snowball sampling. ACP interviewees' selection followed these criteria:

1. Head of the environmental division
2. Staff in charge of some environmental programs
3. Responsible of environmental aspects of the canal's expansion program

The following criteria guided City of Knowledge interviewees' selection:

1. From the online directory, firms that provided environmental services were spotted
2. The initial list contained representative of major groups: international organizations, incubated firms, consulting groups, research center, universities, environmental financing groups. The shortlisted organizations were contacted and finally interviewed those consenting to participate.

Support interviews (Appendix 2) aimed to assess the research problem assertiveness, enhance the understanding of the institutional set-up for innovation, and the linkages between university-industry-government. Snowball sampling was used to select complementary interviewees: the first interviewees in City of Knowledge provided with ideas on who could be a good information source outside of ACP and City of Knowledge. Later, first support interviewees also advised on further interviewees. Hence, the list grew and the informants were combined among government agencies, universities, NGO and international cooperation agencies.

4. Findings and interpretation

4.1. The relationship between institutional set-up, eco-innovation facilitation and synergy building between stakeholders

The Global Competitive Index portrays Panama as the third most competitive in the Latin-American and Caribbean region –after Chile and Puerto Rico. Some assets allow Panamanian competitiveness to close the gap and approach the top rankings in the coming years: infrastructure development, stable macroeconomics, technology absorption and ICT penetration rates (WEF 2010, 32).

The collected empirical materials assert the following National System of Innovation “good practices” (Edquist 2006, 190) to be found in Panama:

1. Provision of Research and Development
2. Competence building

3. Financing of innovation processes and other activities that can facilitate commercialization of knowledge and its adoption

Provision of R&D

The government launched a five years strategic plan in which five areas are prioritized to receive funds for research and development. SENACYT¹ is in charge of providing grants to research projects encompassing knowledge creation in these domains (Panama Executive 2007):

- Multimodal and logistics transports (Panama Canal)
- Information Technologies and Communication
- Biosciences, biomedicine, applied biotechnology, environmental sciences
- Tourism
- Agro-industry

The former Howard military base hosts a campus of the Technological University of Panama. This emplacement is an example of aviation and logistics R&D infrastructure. Besides, City of Knowledge's Technopark attracts medicine and biotechnology international firms which are gradually creating a cluster in these domains. Foreign Direct Investments may fund R&D in this case. International firms settling in the technopark have advantages. First, local universities train human capital doing research in these two areas. Subsequently, the cost of the human capital is less than developed countries. Second, there is the natural capital for doing bio-prospection. Important clinical research institutes which have studied tropical diseases are located in Panama, as the Gorgas Research Institute. Furthermore, the location in Panama of the headquarters of the Smithsonian Tropical Research Institute (STRI) is often highlighted as one of the main research assets of the country (Dettenhofer and Hampl 2009).

Competence building

Competence building encompasses education and training, human capital creation, production and reproduction of skills, and individual learning in the labor force to be used in the R&D activities. Public agencies as SENACYT, IFARHU² and INADEH³, become key funders and executants of projects dealing with this key issue of the national system of innovation.

Panamanian university system, however, struggles to adapt to globalization. The large public University of Panama has traditionally dominated the university system. According to Svenson (2009), globalization entails major consequences over the Panamanian universities. The first consequence is a growing concern on curricula quality. This concern is partly fostered by international cooperation agencies – particularly German-, the interest being to improve the overall Central America research and education quality. It takes form in university accreditation efforts.

¹ SENACYT (National Secretary of Science, Technology and Innovation) is the public agency responsible for funding of R&D and innovation.

² IFARHU: *Instituto para la Formación y Aprovechamiento de Recursos Humanos* (Institute for Formation of Human Resources)

³ INADEH: *Instituto Nacional de Formación Profesional y Capacitación para el Desarrollo Humano* (Institute for Profesional Formation and capacity building for Human Development)

The second globalization's consequence is the increasing demand for competence creation on country's key economic areas. A common Panamanian private sector's critique to Panamanian universities is that students are not competent to fulfill the employment requirements after graduation. Recent efforts have arisen to improve the relations between universities, the private sector and the government. UNEE⁴ is a local "Triple Helix" initiative funded by GTZ⁵. UNEE seeks to promote synergies between universities, government and the private sector. Currently, the project is promoted by the Panama Universities rectors' Council (Morales Córdoba and Quintero de Sanfilippo 2010).

Financing innovation

One interviewee from the National Innovation Agency stated that "Panama is the seventh country [in the world] where it is easy to borrow money, the problem is not the money availability, the problem is the human resource capable of presenting good projects". Based on this, it may seem that one of the good practices of a national system of innovation, which relates to "financing of innovation processes and other activities that can facilitate commercialization of knowledge and its adoption (Edquist 2006, 191) can at first sight apply to the Panamanian context.

Innovation financing schemes comes from direct and indirect sources. Government agencies provide direct funding. Law mandates SENACYT to provide funds for innovation. At lesser extent, other organizations as City of Knowledge, FUDESPA⁶ and AMPYME⁷ also provide with funding to innovation. Yet, these four organizations differ on how the funding origin and procedures. Basically, these organizations administer external funds –indirect, mainly international cooperation agencies.

Indirect funding comes from several organizations. For instance, ECOS S.A. a private equity group located in City of Knowledge. ECOS finances projects dealing with renewable energy, community tourism, biofuels and others. Yet, its operations are regional (e.g. Latin –America, with most projects located in Colombia and Brazil).

Funds are granted for human capacity building in key areas of innovation and research. Still, a "black box" funds provision model is used. This model implies that inputs are alone expected to yield results after having passed by the "black box" –composed by universities, research centers and human capital. However, the literature confers the black box approach an out-casted way to envision innovation fostering (Marinova and Phillimore 2006). As the head of the entrepreneurial innovation division in SENACYT pin-pointed: "Panama is one of the places around the world where it is easy to get funding; the problem is not the money. The problem is to have good and competitive projects presented [to the different innovation awards managed by national or international cooperation agencies]".

The preparation of "good projects" was something that most interviewees agreed is an ultimate responsibility of the universities. However, based on the results, universities seem hitherto to be failing in their metamorphosis from traditional social extension

⁴ UNEE stands for *Universidad, Empresa, Estado* (University, Enterprise, Government)

⁵ German Technical Cooperation Agency

⁶ FUDESPA stands for *Fundación para el Desarrollo Económico y Social de Panamá* (Foundation for Social and Economical Development of Panama)

⁷ AMPYME is the Authority for the Micro, Small and Medium Enterprise (*Autoridad de la Micro, Pequeña y Mediana Empresa*)

URM Latin-America university (Arocena and Sutz 2005) into entrepreneurial university (Etzkowitz et al. 2000). Some comments asserted that “universities’ curriculum is outdated and something must be done”, “universities are preparing students so, once they finish with their studies, they go look for a job; instead of preparing them to create their own job”. University incubators (Etzkowitz 2002) are portrayed as a panacea to tackle this problem. An university entrepreneurship program manager stated: “more courses in which students learn how to draft business plans, which could be added to the existing technical curricula”. As an UNEE officer claimed “the project [UNEE] centers its strategies to create more linkages between universities and SMEs. This will allow universities to work in real problems and at the same time have budget for students’ research and internships (...) but still UNEE is not operative”.

4.2. Illustrating a developing country Eco-innovation: Panama Canal Authority’s Green Maritime route

The 31 December 1999, the Panamanian government officially received stewardship over the Canal infrastructure by the United States government. Before that, in June 1997, the Panama Legislative Assembly approved the Law 19, 1997 by which it established the Panama Canal Authority (ACP). The Authority of Panama Canal (ACP) is a public company steered by a board of 11 directors. One of these directors is appointed by the president of the republic and has the range of minister for canal affairs. Another director is appointed by the Legislative branch, and the nine remaining directors are appointed by the president of the republic as well.

The environmental sustainability perspective of ACP is casted upon its vision statement (ACP 2009, 116):

World Leader in services to the maritime industry and in sustainable development for the conservation of the Panama Canal watershed...

This is reinforced in the business mission statement (ACP 2009, 116):

...We manage and conserve the Canal’s water resources and participate actively in environmental protection, as well as in the sustainable development of the Canal watershed.

Thereupon, drivers for this interest to carry canal’s operations within environmental sustainability frames are twofold: environmental self-regulation initiatives and command and control environmental regulation.

Climate change has become a mainstream issue in the ACP environmental strategies. The “green maritime route” carbon neutrality strategy is considered in this report as an institutional eco-innovation. The eco-innovation relies in the incremental and radical changes introduced in the institutional set-up to establish this program.

A review in the literature highlights the interest of ACP and international cooperation agencies (mainly USAID⁸) to link the watershed protection with potential CO₂ trading mechanisms⁹. In Dale et al. (2003), for instance, North-American scientists along with

⁸ United States Cooperation Agency

⁹ According to an international cooperation officer, USAID supported ACP to organize its environmental protection division, in the early years of the canal management transition towards a Panamanian

ACP staff assess the deforestation in the Panama Canal watershed (PCW) as the main cause for CO₂ releases into the atmosphere. They highlight that reforestation strategies will not be sufficient to offset all the emissions generated by the forest clearance.

Hence, watershed protection and deforestation avoidance cannot be considered an interest of ACP alone, but a subject of importance for several public agencies. For example, ACP launched the CICH¹⁰, in order to coordinate efforts among public agencies to regulate the land use in the watershed. The commission is steered by eight public organizations¹¹ (CICH 2010). Besides, the USAID has also had a long-lasting support for the canal protection efforts, as its Biodiversity conservation in the canal watershed project testifies (USAID 2010).

Watershed protection and a climate change strategy can at a first glance seem to be intertwined subjects. Yet, besides the environmental strategy and the watershed management initiative, ACP carbon neutral operations are sketched as an independent strategy. According to ACP (2009, 150) the objectives to become a carbon neutral company are:

- To reduce CO₂ emissions, contributing with international efforts to reduce global warming.
- To establish a CO₂ emissions baseline within ACP's operations.
- To offset reduced emissions through the establishment of land use change activities yielding multiple benefits for impoverished communities and by quantifying CO₂ emissions of vessels transiting through the Panama Canal compared to competing routes.

These objectives highlight two main areas in which the “carbon-neutrality” can be achieved: firstly by CO₂ emissions offsetting of the company's emissions, and other potential CER buyers –in the case the company enters in a carbon trade scheme-, and second, by the actual CO₂ savings by shortening distances whenever a vessels uses the canal.

Reforestation and silvo-pastoral practices (grazing mixed with trees) have been the most relevant strategies used by ACP in order to offset emissions. Reforestation has become a profitable investment in the country, and a couple of companies visited during the fieldwork have investments in the PCW. For example, teak (*Tectona grandis*) plantations are mentioned as common in the area. Yet, criticism for teak monocultures has already being pointed out in previous studies of the PCW (Wallader et al. 2007, 320). Aware of this, a company in the business only has mixed native and teak plantations. Besides, this has turned to be a competitive advantage as they were the first company in Panama to have plantations of this kind, and have their plantations in areas with positive community impact. Hence, they have sold carbon credits in the voluntary markets, with premium prizes.

administration. The research project which resulted in the paper Dale et al. (2003), was funded by a contract between USAID and Oak Ridge National Laboratory, US.

¹⁰ Inter-institutional Commission for the Watershed of the Panama Canal [*Comisión Interinstitucional para la Cuenca Hidrográfica del Canal de Panamá*]. According to ACP, the creation of this commission and its responsibilities are justified by Art. 4 of the Law 19-1997.

¹¹ Public agencies (ACP, ANAM, MIDA, MIVI, Ministry of government and Justice, Ministry of Economy and Finance), NGO (Fundación Natura) and a representative from the Catholic Church.

Other carbon sequestration strategies are silvo-pastoral practices and agro-forestry promotion among local ranchers and farmers. This ACP initiative has been framed in its “Environmental Economics Incentives Program”, named PIEA for its acronym in Spanish (ACP 2009, 150). According to Fernández (2010), PIEA involves 436 farmers and ranchers in the PCW. The way PIEA works is whenever a farmer who owns a farm, joins the program, he/she must fulfill some conditions –e.g. turn into silvo-pastoral practice, grow improved grass, and protect the forest in his/her estate. In return, these farmers receive in-kind payments (seeds, technical assistance) and some cash, as an incentive to avoid them turning land uses in other which could damage the water quality, or release CO₂ emissions. Furthermore, ACP envisages getting carbon credits by the avoided deforestation, by bundling several of the non-deforested areas located in the farmer’s estates. Later, the payments received in turn of the credits, would be re-distributed among the farmers. However, this is only a project and is not currently taking place.

Carbon emission reduction by using the canal is an interesting way to promote the canal use among ship liners instead of alternate routes. In 2008, the ACP’s environmental sustainability report nicknamed the Panama Canal as “the green maritime route of the world”. By shortening distances, and by avoiding multi-modal combinations of transports (ship-train-truck-ship), the transport of merchandises across continents becomes less atmospheric pollutant (ACP 2008, 29). Moreover, according to the canal master plan, the expansion project is likely to contribute to mitigate the climate change by GHG emission reduction. It is stated that on the one hand the shipping with larger and more efficient vessels, which will be able to use the Panama route rather than the longer Suez Canal route, will imply less GHG emissions. In fact, it is proposed that the canal expansion could be presented as a CDM project by itself (ACP 2006, 35).

As a way to promote this idea among ship-liners and other shipping companies, ACP plans to provide the vessels passing by the canal with a certificate of carbon emission reductions. According to Soto (2010) some studies on the accountability of such certificates were commissioned. The idea is to quantitatively demonstrate in which ways the use of the canal route help companies reduce their emissions.

Analytical category 3: Stimulation of Triple Helix interactions by the ACP environmental strategies

Three major groups of actors can be considered relevant at this stage: international cooperation, consultants and universities. Bilateral relations between the canal authority and some international cooperation agencies can be spotted. The most relevant is USAID, since the early first years when ACP was handed to Panamanians, this agency provided with financial support to create an environmental department.

Later on, this same agency was also involved in the origins of the ACP’s silvo-pastoral project. USAID and the Ministry of Agricultural Development (MIDA) drafted a Policy proposal for better agricultural and ranching practices in the PCW. An outcome of this policy was the Bank of Agricultural Development (BDA) funded loans for ranchers who wanted to implement the better practices in their farms. Subsequently, ACP would collect some recommendations of this USAID/ MIDA program.

Similarly, USAID was involved in the origins of the funding of the Cleaner Production Center of Panama (CNPML). USAID and ANAM¹² prepared a national Policy of Cleaner production. As a result, there was the interest to promote cleaner production practices in the PCW, and a way to achieve so was to create an NGO. The CONEP (National Council of the Private Enterprise) compromised to co-fund the installation of the center, and thus the CNPML was born. Subsequently, the ACP and CNPML carried out some projects together, in order to improve production practices in the tanneries, poultries and piggeries.

Consulting services are framed in the ACP bidding regulations. An online system manages the company's acquisitions. The system is considered as transparent, efficient and equitable by interviewees, and it is often spotted as an example for other public agencies¹³. The system works in this way: when a division has a particular need (service or product), the request is formalized through the bidding department. Then the bidding is posted in the website or by other public diffusion means, and then the best offers (quality and price are selected).

In the environmental domain, the consultants have provided with feedback in some of the initiatives related to the "green maritime route". As this program overlaps with emerging topics as climate change, Clean Development Mechanisms, air pollutants monitoring and the alike, there are niches for consultants. ACP environmental division staff has claimed that they prefer to work with consultants on these specific issues. Therefore, consultants were hired to prepare the baseline for having a carbon footprint monitoring system, for writing PDDs¹⁴ which are then submitted to the UNFCCC, and to carry air quality monitoring. Further, consultants prepare a study which quantifies how GHG emissions are saved when a vessel uses the canal instead of other maritime routes/ trans-modal system.

4.2. Generation of eco-innovation from City of Knowledge

City of Knowledge (CDS) is a "Science, business and technology park" at the former US Fort Clayton military base in the Panama Canal area (CDS 2010a). City of Knowledge's origins can be traced back to 1994 when the industrialist Fernando Eleta Almaran proposed the creation of a "Socratic Square". In 1995, a public private Foundation (*Fundación Ciudad del Saber*) was launched, with the aim to concretize Almaran's idea. Later, the Panamanian government issued the Law Decree n°6, 1998. According to this law, City of Knowledge's main purpose is to encourage innovation, and to foster the establishment of research centers, and knowledge transfer organizations. For this sake, the law entitled *Fundación Ciudad del Saber* to administer the installations of Fort Clayton, and it established a set of tax exemption and fiscal incentives to attract organizations to settle at CDS.

City of Knowledge envisions sustainability as one challenges to work in. This commitment has being shaped by some projects (Tarté 2010):

- Promotion of green entrepreneurship in the Panama Business Accelerator (AEP)

¹² Panama Environmental Authority (*Autoridad Ambiental de Panamá*)

¹³ In fact, recently the Panamanian Government modernized its public acquisitions system. It was modernized under the name of "Panama compra"[Panama buys] (<http://www.panamacompra.gob.pa>) According to some interviewees, this new public system was inspired in ACP's.

¹⁴ PDD stands for Project Design Document in the Clean Development Mechanism argot.

- Promotion of cooperation and synergies among City of Knowledge's affiliated organizations (bilateral, cluster and networks). Examples are bilateral relations between a consulting group and an university to launch a master program in Environmental Management. The cluster of bio-prospection, and as network the launching of the CIDES (International Center for Sustainable Development)¹⁵.
- Promotion of a sustainable infrastructure on campus. For instance, park building constructions and improvements in the coming years will be LEED certified¹⁶.
- Promotion of the "green" organizations settling. For instance, in 2011, the Regional Center for GHG emission reduction will be established in City of Knowledge.

Besides, the sustainable development interest is implicit in the work that affiliated organizations are carrying out. From 159 listed organizations, an overview of their presentation summary accounts 138 different keywords -not all of them related to environment/ sustainability. Yet, a set of keywords were listed using the OECD and Eurostat (1999) environmental services frame of reference (Table 1). An updated approach to the "environmental service cluster" in City of Knowledge results in nine organizational categories: NGO, consulting, research center, academia, maritime, clean tech, government and enterprise incubators (CDS 2010b).

Organizations listed in Table 1 are mixed between profit and no-profit organizations. For example, profit organizations include consulting agencies, maritime companies offering services of R&D, and clean tech companies selling technology. Environmental related activities of these organization range from environmental studies (like consulting companies which can prepare Environmental impact assessments), capacity building (training on specific topics like ISO norms), selling "clean technology" (renewable energies or waste management), or technology related to the maritime sector or the control of operations in the firms.

In the branch of no-profit organizations, there are research centers and academia. From an environmental point of view, research centers' work relates to policy, innovation, knowledge management and environmental studies. Academia comprises universities, NGOs and government bodies. Similarly, innovation promotion government agencies are also located in City of Knowledge. These agencies fund prizes for start-ups and finance settlement of human capital (national or foreigner researchers who propose research agendas).

City of Knowledge Foundation's interest to promote the science park as a sustainability –and thus eco-innovation- hotspot is not coupled with the park's original plan. This has consequences, currently, ICT and bio-tech organizations seem to quantitatively dominate over environmental services providers. Besides, organizations which focus compels environmental services are not providing services in a single cluster, but instead have a broad range of services (which ranks from geophysical studies, capacity building, sustainable development, renewable, policy, planning etc...). Thus, giving the impression that no specialization can be expected in City of Knowledge with regard to a

¹⁵ CIDES was created in 2004. It is an international initiative which groups 90 different organizations including United Nations, environmental grassroots organizations, NGO, Universities, research centers, and government agencies. Its objective is to create an space for generating, exchanging and diffusion of sustainable development (CDS 2010c).

¹⁶ Leadership in Energy and Environmental design (<http://www.leed.net/>)

“green” technology or service, -as for example, renewable energies, or carbon sequestration.

Table 1- Selected City of Knowledge affiliated organizations and associated environmental activities.

	NGO	Consulting	Research center	Academia	Maritime	Clean tech	Government	Enterprise incubator
Education research				X			X	
renewables				X			X	
waste						X		
incubator							X	X
business								X
maritime technology					X			
environmental studies		X	X		X			
operations management		X			X			
refrigeration					X			
consulting maritime					X			
capacity building		X						
sustainable development		X						
renewables		X						
teledetection		X						
ISO		X						
GIS		X						
public funding							X	
environmental policy	X							
sustainable development	X							
planning	X							
environmental governance	X							
knowledge management			X					
policy			X					
innovation			X					

Source: own elaboration based on CDS (2010b).

An explanation for the previous can be found in the late appearance of the sustainable development discourse. Initial conditions that originated City of Knowledge called for financial autonomy in a term of ten years. It is an author’s conjecture that City of Knowledge foundation initially promoted more lucrative ICT and Biotechnologies clusters. In this way, it was easier to secure financial stability. Therefore, a “green cluster” was not initially considered.

Yet, this started to change when new initiatives as the CIDES established on the park. An organization alone, as CIDES cannot explain why the recent shift towards a “greening” in City of Knowledge. Instead, the results suggest that the environmental strategies in the PCW have played the role of “market pull” so this park “greening” to take place.

4.4. ACP and City of Knowledge interactions as source of eco-innovation

Interactions between City of Knowledge and ACP’s environmental strategies had two main characteristics in the past: firstly, City of Knowledge organizations as education/training providers. Secondly City of Knowledge’s organizations respond to bidding offers from ACP as providers of consultancy. In the present time, to these two kinds of relations, a third one is added: knowledge management (Figure 2).

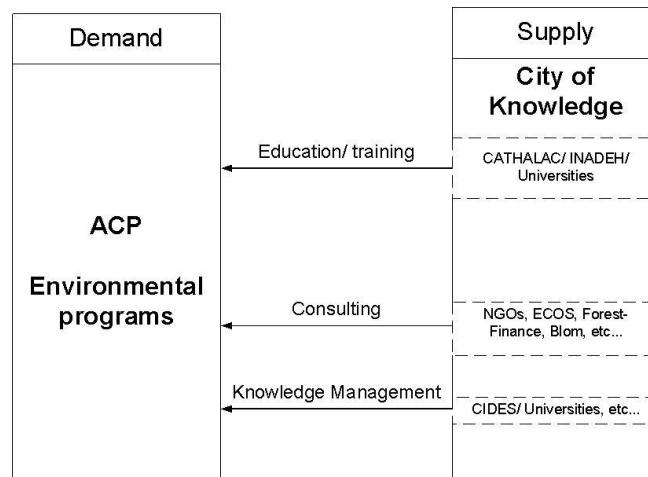


Figure 2 – Past and present relations between City of Knowledge and ACP.

Educational and training activities evidence Triple Helix interactions between industry, government and universities. In a first example, one private firm established at City of knowledge, created agreements with a major national university in order to launch a master program in Environmental management information systems. The government was involved as it provided funding for the program. In this kind of interaction, three strands of a Triple Helix can be spotted: an University, an Industry (as supplier of students and funds for the education), and the government (also as funder of the initiative). Moreover, the role played by City of Knowledge as the entity enabling the interaction, is also something to highlight. To the question whether this interaction resulted with the creation of an innovative organization, it certainly did. According to some interviewees, the master program was one of the first to bring to Panama high level training on environmental technology. This can be classified as an eco-innovation in services offered.

More recently, there is an ongoing project to establish a training center for renewable energy in City of Knowledge. This institutional Eco-innovation, seeks to train a critical mass of local technicians who will be able to install renewable energy technologies, and perform energy efficiency consulting. Project's partners are INADEH and the Spanish Group Mondragon, with the support of UNEP¹⁷ and ANAM. Furthermore, City of Knowledge intermediates along CIDES (Johnson, Darwish and Moreno 2010; CIDES 2010; PA-Digital 2008). Interestingly, there were projects linking group Mondragon with INADEH and ACP in the past. For instance, once the canal expansion program was approved, ACP signed a collaboration agreement with INADEH. A City of Knowledge based training center started training technical staff for the expansion program.

Besides educational activities, consulting offers opportunities for interaction between organizations in City of Knowledge and ACP environmental division. ACP environmental division' ideas are enriched with the insights provided by consultants with regards to the activities and programs. For example, CATHALAC¹⁸ has developed close links with ACP in this particular. From the one side, it has exploited its integrated water resource management experience by training ACP hired educators working on environmental education in the PCW. Similarly, other City of Knowledge based

¹⁷ United Nations Environmental Programme

¹⁸ Water Center for the Humid Tropics of Latin America and the Caribbean (*Centro del Agua del Trópico Húmedo para América Latina y el Caribe*)

organizations have provided consulting to ACP's PCW protection programs.-i.e. Ramsar, and the NGO Panama Verde.

A third type of interaction between ACP environmental division and City of Knowledge concerns knowledge management needs. An ACP interviewee claimed that her organization has a seam of tacit knowledge which has not been properly shared with outsiders. Examples of this knowledge can be found on learning from the application of environmental protection programs and health projects in the PCW. Insights could be shared with the Panamanian society and the scientific community. However, this endeavor requires special language and lies out of ACP technical staff's routinely tasks. An intermediary organization (CIDES) tries to link a City of Knowledge University with ACP.

In fact, the proposed project, aims to create knowledge based upon experiences of community health care in the PCW, and to uncover other issues as for example the relationship between climate change and health. In this way, besides generating knowledge, ACP serves the information for its sustainable development baseline. In exchange, the university ensures internships for its students.

Summarizing, three kinds of interactions have historically operated between ACP and City of Knowledge: education/ training, consulting and knowledge management. The focus on "Triple Helix" highlights that interactions can result in the creation of organizations/ institutions which can foster innovation. Some PCW eco-innovations resulted from these interactions confirming what the theory presupposed. Yet, City of Knowledge does not host all the eco-innovations nor most of the third parties collaborating with ACP environmental strategies. Although niches of eco-innovation for City of Knowledge's organizations were spotted, ACP may not be a lonely "lifter" for eco-innovation in the science park.

5. Conclusions

Based on the previous results, the study conclusions are:

Funding availability for R&D alone is not a solution to innovation fostering. So forth, structural problems make Panama not different from its less developed Latin-American neighbors. Examples of these problems are cultural scripts related to the way politics embed relations between stakeholders and mistrust to local produced innovation. This has explicit consequences in the way Triple Helix interactions take place as it hinders an otherwise easy going interaction among universities, industry and government.

Although large public agencies, as the Panama Canal Authority have mechanisms to ease eco-innovation creation from their own employees; this task is not fully achieved without third party support. In particular, international cooperation agencies and consultants can play the role of eco-innovation stimulators in countries with contexts as the Panamanian. Yet, the way international cooperation and consultants interact with the public agency differ, as well as the stage in which they contribute to eco-innovation fostering. In the case of international cooperation, a clear objective can spark interactions among several actors in the same region, and thus encompass institutional eco-innovations. Concerning consultants, clear and fair rules of the game are the main incentive to canalize diverse and heterogenic potential contributions for institutional eco-innovations.

A third conclusion is that even if contextual conditions hinder Triple Helix interactions in a given developing country, they are still possible to take place. The case shed light on the conditions that make this possible. First of all, the Triple Helix interactions need an intermediary; science parks can fulfill this role by providing incentives whenever these interactions may benefit the science park itself. Secondly, bilateral bottom-up relations between universities and industry can build trust over time and gradually become more structured relations, which given the opportunity will involve the participation of the government. For these relations to succeed a pre-condition is people circulation: individuals coming from the university become the carriers of knowledge and social capital, to ease the relations between the strands of the Triple Helix.

A fourth conclusion is that environmental service provision can become a point of departure for eco-innovation in developing countries. By holding the organizations which provide these services in a single location -e.g. a science park-, information exchange and networking can gradually lead to the formation of a specific "green" cluster.

A hypothesis of this study was not confirmed by the results. The hypothesis considered that the Panama Canal Authority demand for products and services related to its environmental strategy would be a lifter for attracting such firms and its following location in the adjacent science park. In conclusion, it can be said that from a regional scope, market pull cannot be strictly linked to a particular company or a giving activity in particular. This has implications in the planning of "green" cluster formation.

6. Policy implications

This case study has two major policy implications: for local innovation agencies and for other developing countries. In order to go beyond a "black box" approach to promote innovation, the National Secretary of Science, Innovation and Technology (SENACYT) can take a more proactive role by strengthen links between universities, industries and government. For this sake, the entrepreneurial innovation division could follow closer the initiatives of the UNEE (university-enterprise-government) project. The UNEE project which arose from the leadership role by some universities, and which has not already being implemented could be more a first stage for smoothing hitherto separate dialectics between the private sector, the government and Universities. Whenever public agencies take more protagonist role in this project and do not let it vanish, then it will be possible to reinforce Triple Helix synergies.

Other developing countries could learn from the Panama experience with respect to the emplacement of a science park. The existence of a major service or economical activity (in this case the Panama Canal), is not a reason itself to lift the creation of a "green" cluster that responds to this economic/ service activity.

7. Recommendations for further research

Because one of the overreaching aspects of the Triple Helix theory emphasizes the importance of incubation for linking industry and university, some initiatives of the City of Knowledge Business incubator (AEP) try to promote "eco-entrepreneurs", which is a form of translating eco-innovative ideas into reality. A closer examination to "how" actually eco-innovation can be fostered by business incubators could be a matter of research. For instance, by comparative case studies of incubators in different contexts, and lessons learned from these experiences.

8. References

- Autoridad del Canal de Panamá [ACP]. 2006. Plan Maestro 2005-2025: Capítulo 8. Aspectos sociales y ambientales. <http://www.pancanal.com/esp/plan/documentos/plan/acp-plan-08-aspectos-ambientales-y-sociales.pdf> (Accessed December 12, 2010).
- _____. 2008. Informe anual 2008. Panama: ACP. <http://www.pancanal.com/esp/general/reporte-anual/2008/flash.html> (Accessed December 13, 2010).
- _____. 2009. *Annual report* 2009. Panama: ACP. <http://www.pancanal.com/eng/general/reporte-anual/2009/pdf/InformePDFingles.pdf> (Accessed November 24, 2010)
- Arocena, Rodrigo, and Judith Sutz. 2005. Latin American Universities: From an Original Revolution to an Uncertain Transition. *Higher Education* 50, no. 4 (November): 573-592.
- Centro Internacional de Desarrollo Sostenible (CIDES). 2010. Renewable energy center. http://www.cidesint.org/index.php?option=com_content&view=article&id=25%3Acentro-de-energias-renovables&catid=13%3Aproyectos&Itemid=25&lang=en (Accessed December 12, 2010).
- City of Knowledge (CDS). 2010a. Background. City of knowledge Foundation, Panama. <http://www.ciudadelsaber.org/foundation/background> (Accessed December 13, 2010).
- _____. 2010b. Directorio de Ciudad del Saber. City of Knowledge Foundation, Panama. <http://www.ciudadelsaber.org/foundation/directory> (Accessed December 13, 2010).
- _____. 2010c. Admission criteria. City of Knowledge Foundation, Panama. <http://www.ciudadelsaber.org/foundation/admission> (Accessed December 13, 2010).
- Comisión Interinstitucional de la Cuenca hidrográfica del Canal de Panamá (CICH). 2010. ¿qué es la CICH?. Ciudad de Panamá:CICH. <http://www.cich.org/que.htm> (Accessed December 13, 2010).
- Cooke, Philip. 2010. Regional innovation systems: development opportunities from the “green turn”. *Technology Analysis & Strategies Management* 22, no 7 (October): 831-844.
- Dale, Virginia H, Sandra Brown, Magnolia O Calderón, Arizmendis S Montoya, and Raúl E Martínez. 2003. Estimating baseline carbon emissions for the eastern Panama Canal Watershed. *Mitigation and Adaptation Strategies for Global Change* 8: 323-348.
- Dettenhofer, Markus, and Nora Hampl. 2009. Development of a biomedical innovation economy- Panama. *Journal of technology management & innovation* 4, no. 2: 21-32.
- Edquist, Charles. 2006. Systems of innovation; Perspectives and challenges. In *The Oxford handbook of innovation*, ed. Jan Fagerberg, David C. Mowery, and Richard R. Nelson, 181-208. Oxford: Oxford University Press.
- Etzkowitz, Henry. 2002. Incubation of incubators: innovation as a triple helix of university-industry-government networks. *Science and Public Policy* 29, no. 2: 115-128.
- _____. 2008. *The triple helix; University-industry-government; Innovation in action*. New York: Routledge.
- Etzkowitz, Henry and Loet Leydesdorff. 1995. The triple helix---university-industry-government relations: A laboratory for knowledge based economic development. *EASST Review* 14, no. 1: 14-9. <http://www.leydesdorff.net/th1/index.htm> (Accessed November 24, 2010).
- Etzkowitz, Henry, Andrew Webster, Christiane Gebhardt, and Branca Regina Cantisano Terra. 2000. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy* 29, no. 2 (February): 313-330.
- Fernández, Tomás. 2010. Interview by author. November 9, transcript, Panama Canal Authority Environmental Division.
- International Association of Science Parks (IASP). 2010. Science park ; IASP Official definition. International Association of Science Parks. <http://www.iasp.ws/publico/index.jsp?enl=7> (Accessed November 24, 2010).
- Johnson, Linda, Darwish, Moisés and Juan Moreno. 2010. Interview by Roberto Rivas-Hermann. December 2nd, transcript, City of Knowledge International Center for Sustainable Development, Panama.
- Lehmann, M., P. Christensen and B. Johnson. 2010. Partnerships and sustainable regional innovation systems: special roles for universities? In *Facilitating sustainable innovation through collaboration*, eds. Joseph Sarkis, James J. Cordeiro and Diego Vázquez Brust. Dordrecht: Springer.
- Marinova, Dora, and John Phillimore. 2003. Models of innovation. In *The International handbook on innovation*, ed. Larisa V. Shavinina, 44-53. Amsterdam: Pergamon.
- Morales Córdoba and Edilsa Q. de Sanfilippo. 2010. *Modelo innovador y dinámico de vínculo Universidad –Empresa –Estado*. Panamá: Universidad Tecnológica de Panamá.

- Mowery, David C., and Bhaven N. Sampat. 2006. Universities in national innovation systems. In *The Oxford handbook of innovation*, ed. Jan Fagerberg, David C. Mowery, and Richard R. Nelson, 209-239. Oxford: Oxford University Press.
- Organization for Economic Cooperation and Development (OECD). 2009. *Eco-innovation in industry; Enabling green growth*. Paris: OECD.
- Organization for Economic Cooperation and Development (OECD) and Eurostat. 1999. *The environmental goods and services industry; Manual for data collection and analysis*. Paris: OECD. http://unstats.un.org/unsd/envaccounting/ceea/archive/EPEA/EnvIndustry_Manual_for_data_collection.PDF (Accessed November 24, 2010)
- Panama Executive. 2007. *Plan Estratégico Nacional para el Desarrollo de la Ciencia, la Tecnología y la Innovación 2006-2010*. Resolución de gabinete no. 11 de 2 Febrero 2007. Ciudad de Panama: Gaceta Oficial Digital. <http://www.senacyt.gob.pa/media/anunciosAgendaInnovacion/pecyt%20actualizado%20febrero%202007.pdf> (Accessed December 12, 2010).
- Panama América. Online edition. 2008. Clayton; Instalarán centro de energías renovables. February 28. http://www.pa-digital.com.pa/periodico/buscador/resultado.php?story_id=649605&texto=mondrag%F3n (Accessed December 13, 2010).
- Patton, Michael Quinn. 2002. *Qualitative research and evaluation methods*. 3rd ed. Thousand Oaks: Sage.
- Schienstock, Gerd. 2005. Sustainable development and the regional dimension of the innovation system. In *Towards Environmental Innovation Systems*, ed. Matthias Weber and Jens Hemmelskamp, 97-113. Berlin: Springer.
- Svenson, Nannette Archer. 2009. The effects of globalization on the Panamanian university system: 1990-2007. PhD diss., Tulane University.
- Tarté, Rodrigo. 2010. Interview by author. December 15. Personal Email.
- United States Agency for International Development (USAID). 2010. Biodiversity conservation in the canal watershed. Project description. Panama City, USAID. http://www.usaidcbpanama.org/index.php?option=com_content&task=view&id=15&Itemid=33&lang=en (Accessed December 13, 2010).
- Wallader, Steven, Sandra Lauterbach, Kristan Anderson, Fuphan Chou, Jesse Muir Grossman, and Catherine Schloegel. 2007. Existing markets for ecosystem services in the Panama canal watershed. *Journal of Sustainable Forestry* 25, no. 3: 310-336.
- World Economic Forum (WEF). 2010. The global competitiveness report 2010-2011. Geneva: World Economic Forum. <http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm> (Accessed November 24, 2010)

9. Appendix 1.
Conducted interviews with organizations in City of Knowledge and ACP

Position	Organization	Description
Environmental Division/ Carbon neutral program officer	Panama Canal Authority (Autoridad del Canal de Panamá- ACP)	Public company which has in charge the administration of the Panama Canal.
Environmental division/ Watershed management officer		
Watershed management		
Environmental division head		
Panama canal expansion project_Environmental program head	ACP	For the expansion project, ACP has created an autonomous unit with its own divisions (including its own environmental manager).
Project managers	International Center for Sustainable Development (CIDES)	International research knowledge management center located in City of Knowledge.
Director CIDES/ Head of the Sustainable Development Department, City of Knowledge Foundation	CIDES/ City of Knowledge Foundation	
Project manager	Ingeniería Avanzada	Private business started in City of Knowledge incubator. They offer consulting in geomatics and design.
Project manager	Louis Berger group	International consulting group, its specializations are civil engineering, environmental studies, government building, etc.
Manager	Forest Finance	German finance group for forestry projects, its stockholders invest in several countries of the region.
Public relations officer	Empresas ECOS S.A.	Private (Swiss owned) invest management group, they finance environmental technology development projects, eco-tourism, and the like in Latin-America (most of their investment in Brazil)
Manager	BLOM Geo-spatial systems	International consulting group on teledetection.
Project officer	Water Center for the Humid Tropics of Latin America and The Caribbean (CATHALAC)	International research center on water management.

10. Appendix 2.
**Conducted support interviews with public agencies, private companies, NGO
and others**

Position	Organization	Description
University-Government-Enterprise Project (UNEE) coordinator	Technological University of Panama (UTP)	Public university specialized in Technology. They are one of the partners on the UnEE project. A local triple helix initiative.
Hydraulics and Hydrology Research Center (Centro de Investigación en Hidráulica e Hidrología- CIHH) researcher	UTP	This UTP based lab has long standing experience of collaboration with ACP in research, development and staff formation.
Faculty of Industrial Engineering Professor	UTP	Former PhD student ACP/ UTP in logistics improvement project.
Head of IDEA –Applied Enterprise Development Institute professor	Universidad Latina	Universidad latina is one of the partners in the UnEE project, and also participates to the SIDEP initiative (university incubators)
Rector and Head of the Panama Universities Rectors’ Council	Universidad Latina	
Head of Enterprise Innovation department	National Secretary of Science, Technology and innovation (SENACYT)	Public agency in charge of promoting innovation, and funding projects.
Mission Environmental Officer	USAID (United States Agency for International Development)	Since the 1980s they have promoted environmental protection programs in the canal’s watersheds.
Port pollution prevention and control Department head	Maritime Authority Panama (AMP)	Public authority in charge of managing the maritime sector outside of the canal’s boundaries (ports and open waters). Moreover they give licence for vessels operating with the Panama flag (second fleet in the world).
First Tuesday innovation program head	Foundation for Social and Economical Development Panama (FUDESPA)	An NGO funded by the private sector, its purpose is to promote business initiatives.
Vice-manager	Cleaner Production Center, Panama (CNPML)	An NGO started as a joint project by ANAM, USAID, and CoNEP, initially it had the purpose to promote cleaner production in companies set in the PCW.
Environmental Economics Department officer	National Authority of the Environment (ANAM)	The unit of Environmental economics is drafting regulations on Payment for Environmental services and Eco-labeling.