

The Pearl River Delta region is the largest growing and fastest developing delta areas in the world, embracing a population of approximately **60 million inhabitants**. Under such conditions, an evident high level of urban density and pollution is deeply affecting the metropolitan areas of the whole river delta, its ecology and its natural dynamics.

The intense development and the different policies adopted by different entities in the Delta are endangering the region. A specific **landscape strategy** could be a solution to the environmental urgencies in question in this territory, like CO₂ emissions, increasing flooding problems, urban sprawl, habitats alteration, energy consumption.

RE-GENERATION DELTA

strategy for a sustainably managed Pearl River Delta

The zone known as **The Frontier Closed Area**, between Shenzhen and Hong Kong, is chosen as the main study case for the Re-Generation Delta proposal.

This land has been politically preserved in the past 60 years and nowadays it is in a limbo between the progression of a city in expansion as Shenzhen and the preservation from further construction on the Hong Kong side.

Re-Generation Delta investigates a strategy able to prevent this area from future urban transformations, keeping the balance with the existing ecosystem in an active way for the local productivity and energy-demands. Exploiting the specific condition of the territory, this artificial landscape would be gradually regenerated into a large system of ponds for the harvest of algae.

The new proposed scenario will trigger several environmental benefits, while opening doors to new potential green activities.



ON SITE: EXPLORING AND DISCOVERING THE FRONTIER CLOSED AREA

Because urbanization was prohibited and access was allowed only with specific permit, the FCA was able to develop into an ecological paradise. The cultivated ponds and the plots in this area of 28 square Km on the edge of the cities, have been hosting for years only crops on the upperland, fish and shrimp ponds in the lowerland.

At present days most of the fishponds are taken over by mangrove or reedbeds, if not abandoned to their course; the high presence of water is fortunately the main factor of the high biodiversity of both plants and animals populating the area. The only human presence is registered in small agriculture activities and villages scattered kilometers from each others. However, it seems this situation will not last for long.

A VERY RICH ECOSYSTEM ENDANGERED BY URBAN SPRAWL

Despite being located within one of the most densely populated regions of the world, this stripe of land is the habitat of one of the richest ecosystem, but unfortunately many species are getting endangered increasingly. The area is even part of the "East Asia - Australian Flyway", one of the world's most important waterbird routes, involving 50 million birds stopping here on their routes to Russia, Alaska and Australia.

If the waterscape would leave space for urban transformations, the changes would drastically interrupt the ecological flows, not only locally but with global range of reach and drastical consequences on the ecosystem.

In 2012, already 700 hectares of this interdicted land have been opened to the population, other 1500 will by 2015, and for 2020 there are plans for new developments, with as many discussions going on.

It will be a huge loss for both cities if this land would become the next victim of the ongoing urban sprawl and destroyed by real estate investments. If the land could become productive and financially advantageous, without reducing the water presence and the nature density as proposed in RGD, it would be the optimal solution for the site!

Among the accessible areas of the FCA, an area of 3 square Kilometers have been chosen as test ground for analysis and location for the future design proposal.

REGISTERED BIO-DIVERSITY:

- 400 species of **bird**, 26 endangered
- 260 species of **tree**, 9 endangered
- 118 species of **butterfly**, 9 endangered
- 52 species of **dragonfly**, 7 endangered
- 31 species of **fish**, 1 endangered
- 29 species of **reptiles**, 9 endangered
- 27 species of **mammals**, 6 endangered
- 1 endangered species of **white dolphins**
- 1 unique species of **Horseshoe Crab**

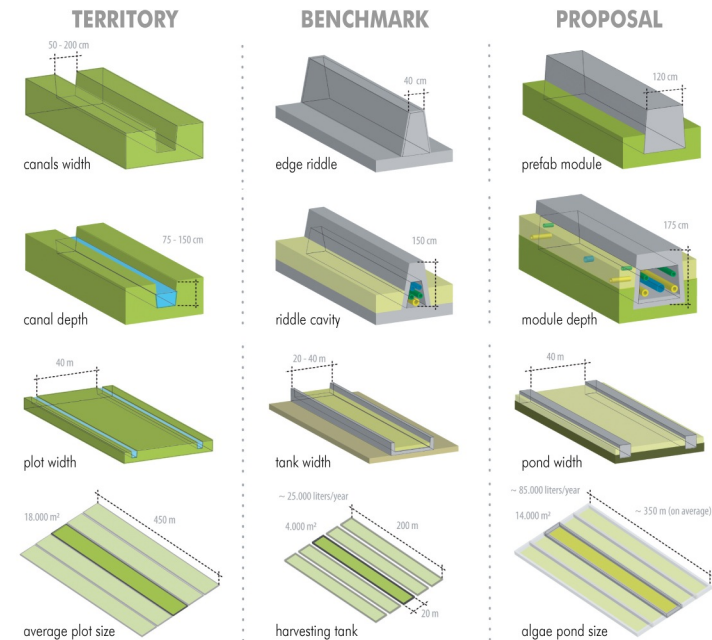


LANDSCAPE ANALYSIS AND COMPARATIVE STUDIES

Thanks to on-site surveys and cartographies, it has been possible to analyse the grammar of the existing landscape and estimate precisely the measurement of different features, in order to compare them with the selected benchmarks, drawing the following conclusions:

- The large size of the plots/ponds are optimal for becoming harvesting ponds because what counts is the max amount of surface layer exposed to direct sunlight;
- The amount of fresh water needed is directly available on site;
- Due to the existing texture drawn by the system of canals and its organization, the construction of the new ditches will be far less expensive than it would be anywhere else!

This diagram shows the similarity between the dimensions of the landscape components and the average technical needs of the algae-farms analysed as reference.



FIRST STUDY CASE: BOONSOM SPIRULINA FARM

Ban Kad, Chiang Mai, THAILAND

Boonsom Spirulina Farm is the largest in Thailand, with 40,000 square meters of growing ponds area, with over 20 years of experience in this business, founded by the pioneering researchers Professors Jiamjit and Somchye Boonsom. This study case has been relevant not only for understanding the harvesting methodology and fundamental technology for optimizing the harvest and the extraction, but even for the social and economical benefits that the different by-products they create are having on a programmatic level.

This farm is focused on biomass production more than biofuels, using a semi-closed system based on a farming model and a farming mentality, making use of standard agricultural and irrigation components for harvesting spirulina algae. Beyond making green natural cattle food supplements and fertilizers, this farm has an inviting and innovative agro-tourism program with a spirulina health spa and a serie of healthy by-products, ranging from food (like spirulina waffles, ice cream, beer and soft drinks) to pharmaceutical products (like facial masks, and homeopathic medicines). These features are a successful secondary stream of business, attracting visitors and customers for on site experience, eventually spending some days over the farm for a full program of learning activities and relaxing body-care ones.

Having to face periods of heavy rainy seasons, they developed a sort of plastic cover for their ponds (also called plastic mulch) that can extend their peak harvesting season from six months to 240 days. They apply and retrieve the solar cover with low-hp tractors resulting in a low labor cost: they claim that one man and one implement can service 160 acres at a cost of only \$35K/acre!

Oil extraction is not necessary here, as the aim is to produce high omega-oil content algae biomass. Harvesting is accomplished via a simple flocculation system emanating CO₂ from the bottom of the ponds, a system invisible from the outside that maintains a general natural look of the whole area.



SECOND STUDY CASE: UNI-ONE ALGAE CULTURE AND BIO FARMING

Semporna, Borneo, MALAYSIA

UniOne Group is a registered bio-tech company operating in Malaysia since 1996, particularly dedicated to modern marine culture and integrated agriculture systems, addressing the global issues of "food security and health crisis" as their statement.

UniOne developed in East Malaysia an agri-industrial park comprehensive of 6000 acres of tropical palm trees for the production of biofuel, 2000 acres of aloe forest, 10.000 of tropical fruit production base, and they are producing the highest quality of bird's nest in the world. Furthermore, by the sea side within the large shallow waters of the Semporna region, they have more than 5000 acres dedicated to the production of seaweed, with the goal of expanding to 25.000 acres in the next 3 years, becoming the largest production of seaweed in the world.

At the current status of their productive cycles, seaweeds are used for providing the large amount of fertilizers rich of proteins that they need for their vast cultures in the hinterland, and also as organic material for feeding fishes cultivated within an experimental system of integrated agriculture, where comprehensive cultures of fish, fruits, vegetables, flowers and rice are harvested in proximity of each others, optimizing the flow of resources needed and the cycles of resulting biological scraps, with relevant savings in terms of energy, water and fertilizers usage.

This study case in Malaysia has been useful not only for understanding the processes and benefits of integrated aquaculture and agriculture systems, but also as a demonstration of the sustainability of such green productions, that can trigger in short time a radical change in the management of the land, improving the conditions of the existing rural activities, with consequential social benefits for the local population that is living depending on them.

Malaysian government played a key role in developing this green business, providing permissions for acting in such non-urbanized areas, and emanating consistent fundings dedicated to preserving and implementing the local land-based activities: a perfect benchmark for demonstrating the utility of RGD proposal in the Frontier Closed Area, that is dealing with very similar circumstances!



RE-GENERATION DELTA AT "ARCHITECTURE & ARCHAEOLOGIES OF PRODUCTIVE LANDSCAPE"

IUAV University, Venice, Italy

In the occasion of presenting ReGeneration Delta at this symposium, a very interesting example of energy-production with algae has been discovered and investigated.

The idea of EnAlg is to build a bio-electric power plant in the Venice lagoon in order to produce electricity through combustion of algae. The bioelectric power plants use photo bioreactors to produce biomass through the photosynthetic reaction performed by algae, CO₂ and the sunlight. The bioreactors are arranged vertically in order to ensure a high efficiency of light use by algae.

The bioelectric power plant consists in two parts: an area where the algae are cultivated and another where biomass is converted into energy. Algae are harvested in plastic incubators and their photosynthesis products (algal biomass) power a gas turbine which generates electrical energy. Then the resulting CO₂ emissions from the gas turbine are captured and reused to produce new biomass: in this way algae can provide a clean source of energy. The bioelectric power plant can operate for 8000 hours per year, far beyond than other renewable powers such as wind or solar power, and biomass can be generated continuously. In addition, many molecules can be extracted from algal biomass, such as hydrocarbons, carbohydrates and proteins which can be used to produce biofuels, lubricants, pharmaceuticals and nutraceuticals compounds, and other diet supplements.

In this case in Venice, where a large open-air ponds system for harvesting of algae is not considerable, the production of biomass needs to be engineered within closed systems (as the bio-reactors), with higher realisation costs. Adopting a similar green power plant infrastructure as a layer upon the regenerated landscape scenario of algae ponds proposed in Re-Generation Delta, would drastically reduce the financial aspects of the project, making it a very appetitive investment for any stakeholder.

RE-GENERATION DELTA AT "2nd ANNUAL INTERNATIONAL CONFERENCE ON ALGAE"

AICA BIT Congress, Hangzhou, China

This conference has been a venue where a multi-disciplinary group of over 200 experts about algae have been publicly showed the latest results in their research and studies. The 3 days long gathering created the perfect environment for exchanging opinions, know-how, references and networks, outside the main schedule of the conferences.

The large amount of participants from world-wide, is symptom of the importance that algae are increasingly acquiring in recent years within the scientific community and in the niche of investors, especially for the aspects related to biomass and biofuel production.

Seaweeds are subject of very different fields of studies, and algae are often seen as a threat in many populated natural environments. The possibility of crisscrossing scientific results and studies from different points of views and fields of actions, can lead to the right intuitions for turning problems into solutions.

Attending the track of lectures dedicated to "Harmful Algae Blooms and Control", it has been very useful to learn about the studies of Dr. Jagroop Pandhal (Research Fellow and Lecturer, University of Sheffield, UK) and Dr. Rob Uittenbogaard (Senior Specialist at Deltares), investigating the causes of algal bloom formations, microcystis scum formations, their remediations and their bio-physical explanations.

The unprecedented discovery of finding the reason of algae blooming in the micro bubble growth caused in the water by oxygenic photosynthesis, leads to understand the remedies to such growth as resources for an environment aiming, instead, at producing bio-mass in the most efficient way!

These studies are providing fundamental literature, examples and data for developing the optimal engineering of the new infrastructural establishment proposed in RGD.

Delta Alliance

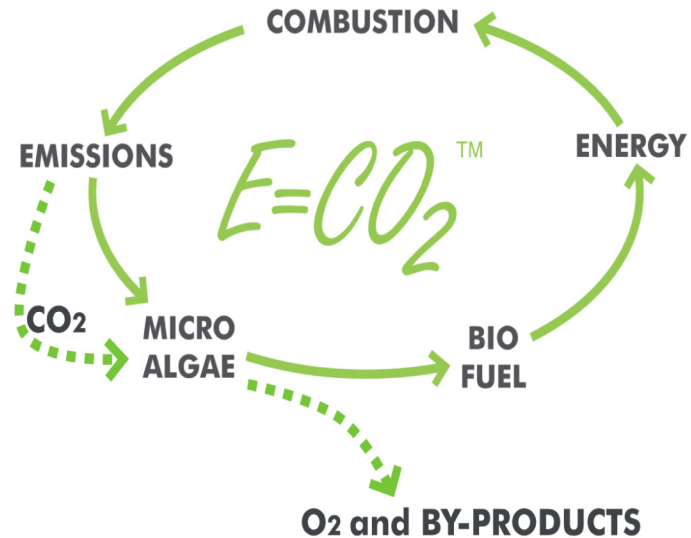
A SUSTAINABLE AND PRODUCTIVE LANDSCAPE

Harvesting micro-algae has been proven to be the most efficient way of producing biofuel and biomass nowadays: not only the production is on average at least eight times bigger but even faster, in facts the whole process, from graft to collection and squeezing, lasts only three days. Micro-algae grows faster and reproduce themselves only by processing the sunlight (or appropriate lighting systems for overnight production) and absorbing the CO₂, releasing oxygen in the atmosphere as result of the photosynthesis. This process has obvious positive consequences on all the surrounding environment, interacting friendly with it and its fauna and preserving their natural condition.

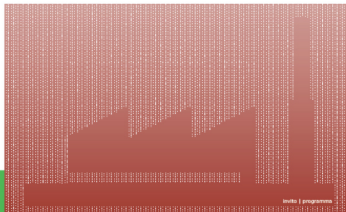
Scraps and waste from the production are raw materials rich of proteins that can be recycled directly by the rural activities in the polder (as cattle feed and fertilizer) or turned into a various amount of by products, and therefore promoting the establishment of new potential activities that would enrich the attractiveness of the polder.

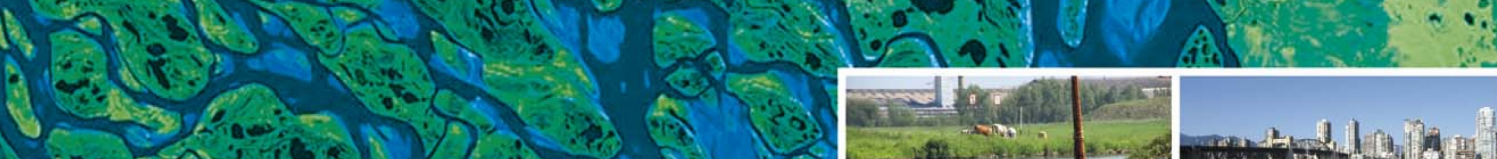
If we consider the intervention on a broader scale, we can see a great potential in turning the rural landscape of the Pearl River Delta into a system of harvesting ponds: all the hinterland area could benefit from this transformation, ensuring enough production of raw bio material for fueling a bio-electricity powerplant installed on site, able to produce an amount of electricity estimated to satisfy about 50.000 homes.

Being the algae growing and reproducing themselves thanks to CO₂, and being the new generation of bio-power plant working via combusting biomass and therefore emitting (cleaner) CO₂ out of the process, we can see how the whole system could sustain itself in a green closed loop of resources, outcomes and needs, that would ensure the requirements for a sustainable development of the area. Such conditions are creating a safe and pro-active flows of energies that will ensure a long term survival of such establishment, turning nowadays problems into tomorrow's solutions!



diagrams: energy flows concept and strategy, by Federico Curiél

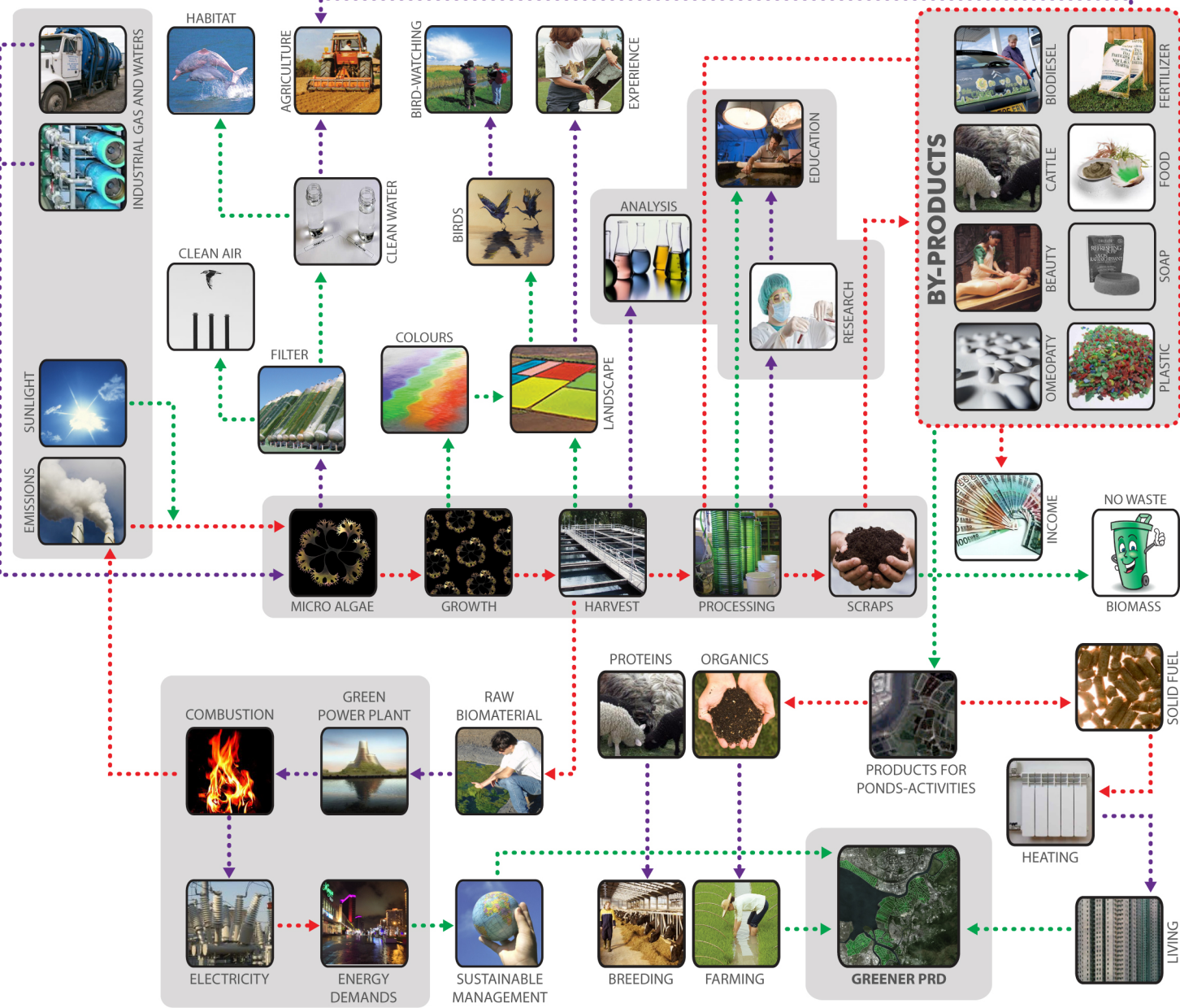




PROCESS

EFFECT

ACTIVITY



WHAT IS RE-GENERATION DELTA?

Re-Generation Delta (RGD) began in 2012 as a research study proposed in occasion of the **Delta Alliance Young Professional Award**, which aim was to challenge for the best innovative solutions for a sustainable future of delta areas in the world, in line with the **Rio+20 Summit** that year. In that occasion RGD was presented among the 3 finalists, and received scientific and financial support for furthering the research.

Experiencing in person the existing conditions and morphology of this rural landscape scattered along the coastline of the Pearl River Delta, and understanding the role it plays nowadays within the urban developments in the Guangdong region, the goals of RGD in the initial phase were the following:

- 1) defining a strategy for this territory able to make it coexist with the nearby megalopolises in expansion, preserving its natural condition while providing new processes for a sustainable management of the land;
- 2) demonstrating how a large-scale system of algae harvesting ponds would be the optimal solution for regenerating the landscape into a new productive scenario, generating a green loop of activities, resources and effects, without creating frictions between the metropolitan administrative zones;
- 3) providing a new infrastructural establishment that, despite its productivity and ecological purposes, would be designed to act as a physical barrier towards the sea, preventing the worst consequences of floodings in proximity of the high-densely populated urban areas in the delta.

The second phase of the research narrowed down the scale of the investigation, with on-site surveys of the areas individuated for the intervention, and it deepened the technical knowledge about algae harvesting and processing, studying similar existing production realities. Different projects in USA, Malaysia and Thailand have been taken as benchmark for comparative studies and for evaluating the practical benefits of this green activity, in terms of economy, yields, ecology, beneficiaries and various possible by-products.

RGD has been presented and participated during international venues specifically dedicated to the subject matter, as "Architecture and Archeologies of the productive landscape" in Venice, and the 2nd International Congress of Algae in Hangzhou.

The multi-disciplinary audience and the professional participants contributed to the exchange of know-how, study cases, cutting-edge technologies and scientific progress, leading to the intuitions that determined the programmatic definition of the proposal, and the direction to take in the bioengineering of the new green infrastructure.

This territory can turn into a main source of biomaterial for sustainable energy production by new generation of electric plants, contributing to the surviving of these non-urbanized areas while implementing the rural activity.

PROJECT TIMELINE

RE-GENERATION DELTA (RGD)

- 12.04 RGD submitted for Delta Alliance Young Professional Award
- 12.05 RGD among 10 best solutions (out of 53) and selected for publication by Delta Alliance
- 12.06 RGD chosen as one of the 3 final winners of the Young Professional Award
- 12.06 RGD presented during the RIO+20 UN Conference in Rio de Janeiro, Brazil: "Green economy in the context of sustainable development and poverty eradication"
- 12.10 RGD presented during the International Conference held in Venice, Italy: "Architecture and archeologies of the production landscapes"
- 12.11 RGD published in IUAV Journals, n.119-2012
- 13.01 RGD receives first sponsorship by Delta Alliance for further research development
- 13.02 RGD peer review by expertise board: Alterra Wageningen UR + Arcadis + Grontmij
- 13.03 RGD research proposal translated into Chinese version
- 13.04 First benchmark case study visited: Spirulina Farm in Chiang Mai, Thailand
- 13.06 Second benchmark case study visited: UniOne's algae farm in Semporna, Malaysia
- 13.08 On-site surveys of selected areas in the Pearl River Delta for the proposed intervention
- 13.09 RGD presented at the International Conference AICA 2013 held in Hangzhou, China: "2nd Annual International Congress of Algae 2013"



WHAT'S NEXT?

In the next research phase, RGD aims at defining the proposal programmatically and concretize it on the architectural scale design. The selected area of 3 square Km, by the Frontier Closed Area, will be the setting of the first set of algae harvesting ponds that will constantly produce biomass (estimated 300 dry tons per year) to be provided to a power plant that will produce green electricity on site, preventing hundreds of thousands of CO₂ from being emitted and eventually integrating in the system the combustion of local dairy manure and dry waste.

The new plant will be a landmark in the new scenario by its iconic design, symbol of a new phase of ecological and sustainable development of the region. The new establishment will make the landscape infrastructured and allow not only accessibility for the people but experiences on site as well, while producing economical advantages by its productivity.

Thanks to the local support of DGJ Architects & Landscapes in HK and the HIT Institute of Technology in Shenzhen, RGD will reach an outcome to be submitted to the authorities, aiming at concrete fundings for a phase of mock-up, economical evaluations and testing on site.

DGJ ARCHITECTS & LANDSCAPES

**ALTERRA
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RIO+20
United Nations Conference
on Sustainable Development

Delta Alliance