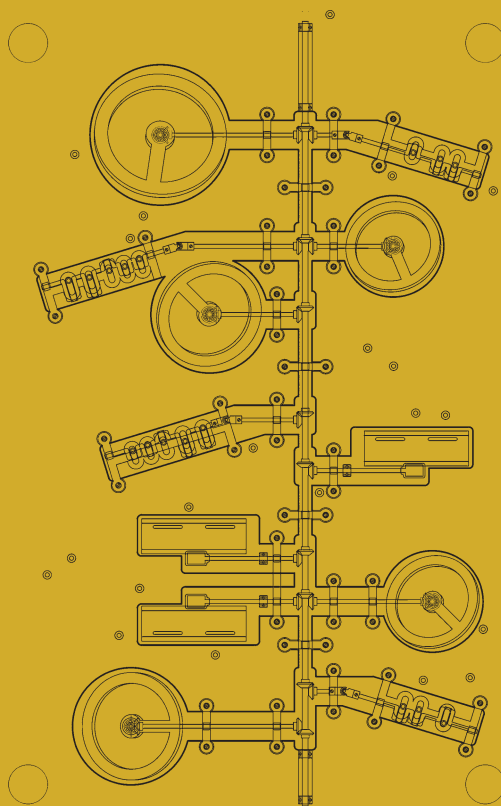


# Envirographic and Techno Natures



by Smout Allen

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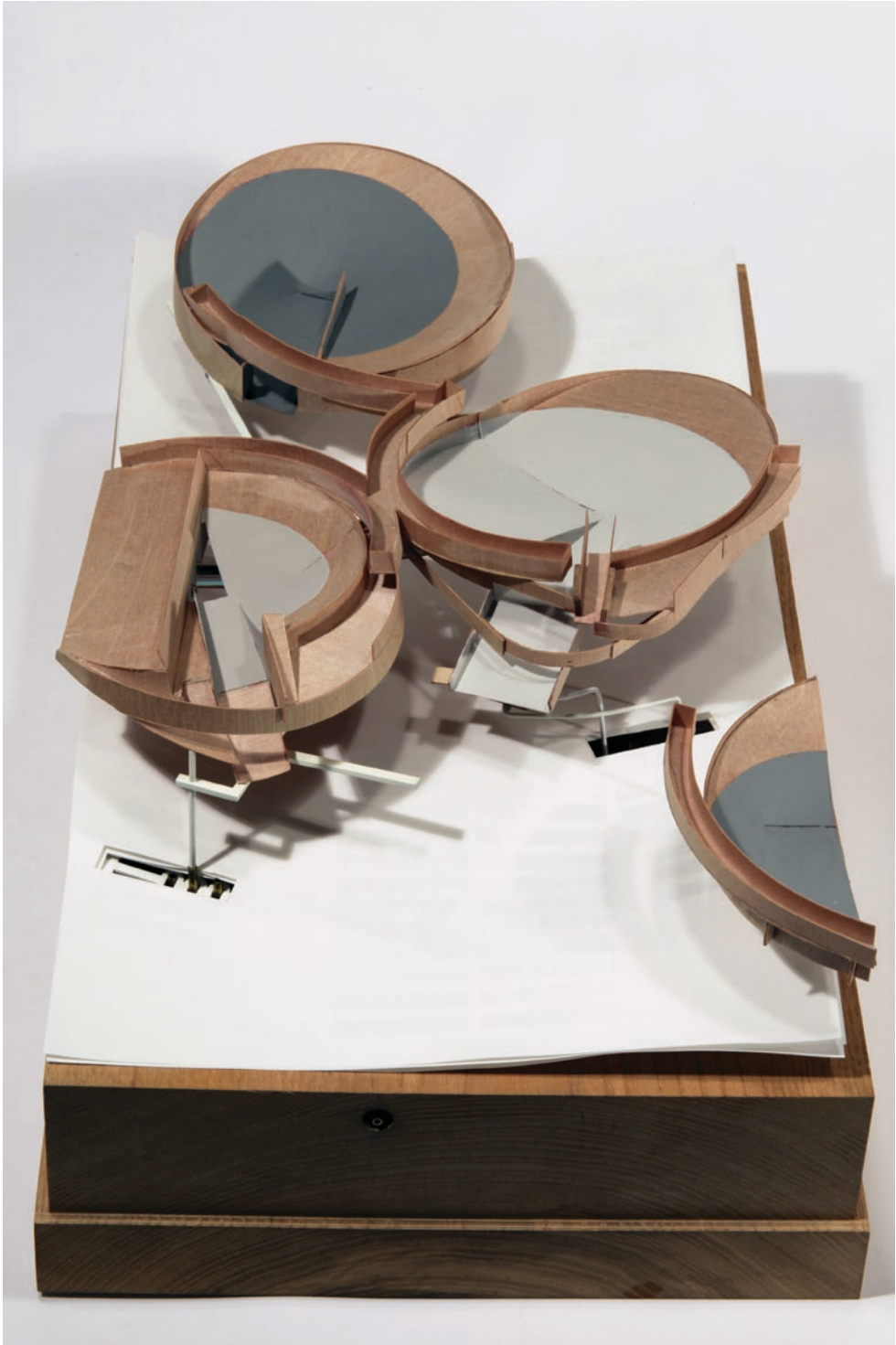


## **Project Details**

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Practice:	Smout Allen
Designers:	Mark Smout and Laura Allen Mark Smout and Laura Allen contributed equally to this project through their joint practice, Smout Allen.
Title:	Envirographic and Techno Natures
Output type:	Design
Exhibition:	<i>Landscape Futures: Instruments, Devices and Architectural Inventions</i>
Venue:	Center for Art and Environment, Nevada Museum of Art, Reno, USA
Dates:	13 August 2011 – 19 February 2012
Funding:	Graham Foundation; Andy Warhol Foundation; Nevada Museum of Art; Southern California Institute of Architecture (SCI-Arc); University of Manitoba; Bartlett School of Architecture Research Fund
Fabrication team:	Johan Hybschmann, Kyle Buchanan, Sandra Youkhana, Jon Kaminsky, Amy Hiley, Ioana Barbantan, Janinder Bhatti and Richard Stonehouse, with assistance from the Bartlett School of Architecture Workshop and Chris Martin at the Nevada Museum of Art
Other exhibitors:	David Benjamin and Soo-in Yang (The Living), David Gissen, Mason White and Lola Sheppard (Lateral Office), Chris Woebken and Kenichi Okada, and Liam Young

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## Statement about the Research Content and Process

### Description

**This environmental architectural design research examines climatic and geographic processes. It focuses on how conservation landscapes—such as Lanzarote and the River Severn Estuary—enable the production of environmental architecture, especially focusing on the potential for hydrological technologies to reflect the specific qualities of the site, and to generate new experiences of a conservation area, and sustainable design. This architectural approach exposes the distinct cultural, geographical and geomorphological qualities of the landscape, and offers new modes of ‘conservation’ to the visitor. In the Lanzarote and the River Severn examples architecture is conceived as an active component of the landscape.**

### Questions

- 1. How do landscape management and resource preservation provide access to new sustainable architectures and experimental environmental technologies?**
- 2. How do these technologies and design interventions reflect the specific cultural context of occupation of protected landscapes?**
- 3. How can the hydrological qualities of the site be expressed as a sustainable architectural design response?**
- 4. How do these architectural interventions allow users to reinterpret and experience landscape in previously unimagined ways and how do they function?**

**1 (previous page)**  
**Instant Islands for**  
**the Severn Estuary.**  
**Model constructed**  
**from wood, paper,**  
**paint, glass and**  
**Perspex.**  
**350mm × 180mm**

**2 (previous page)**  
**Envirographic**  
**Instrument:**  
**Water sampling at**  
**Frampton on Severn,**  
**Gloucestershire**

## **Methods**

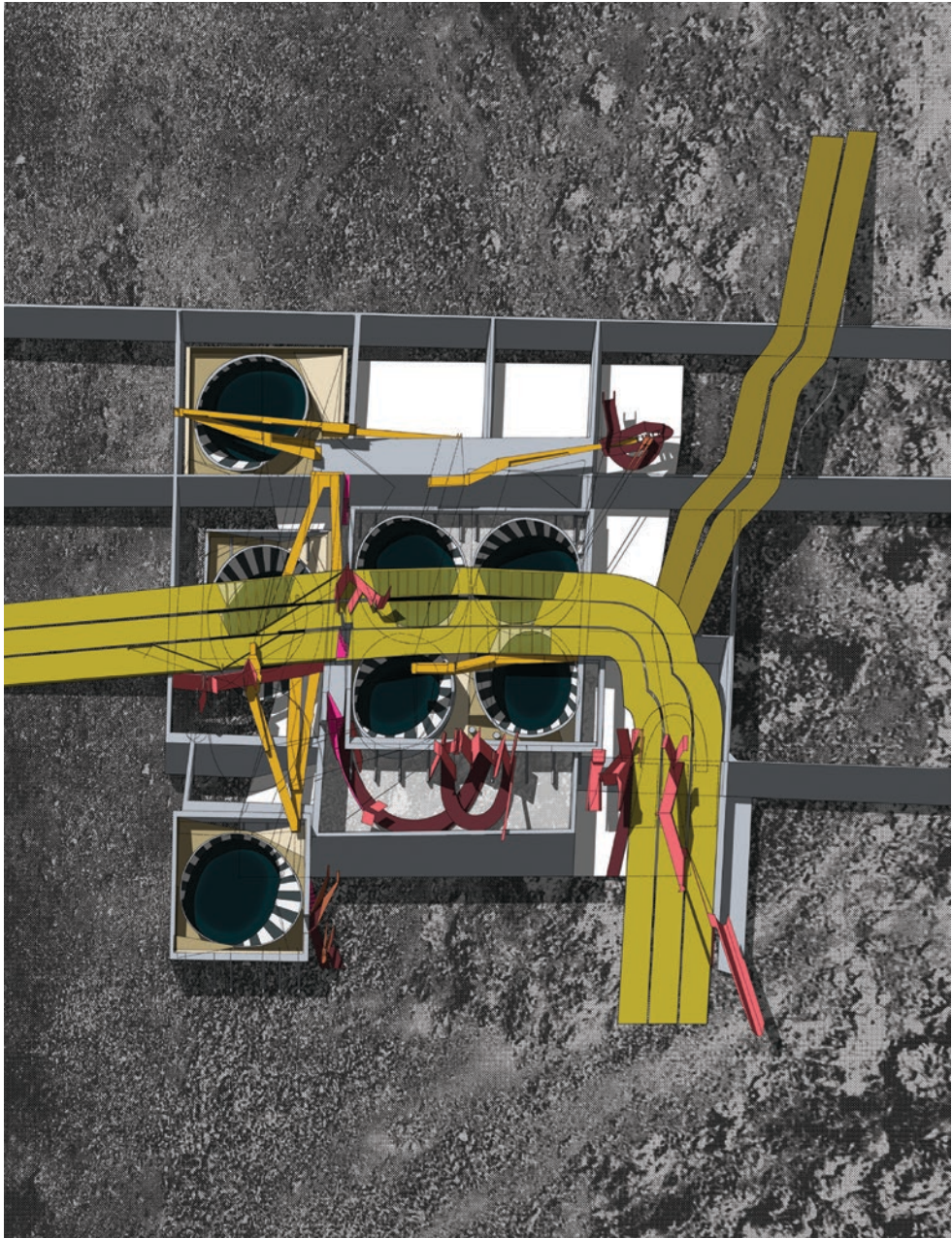
- 1. Understanding landscape management and preservation of resources.**
- 2. Testing technological interventions with the site which enhance the sustainability issues.**
- 3. Generating experimental technologies and design interventions that engage with the specific cultural contexts of occupation in the land.**
- 4. Prototyping hydrological responses.**

## **Dissemination**

**The work has been exhibited in Los Angeles, London, Reno and Winnipeg. It has been published in one book and two journal articles; reviewed in *Architectural Review*, *Flaunt* and *Blueprint*; and presented in six invited talks in the US and UK.**

## **Statement of Co-authorship**

**The authors are jointly responsible for all conceptual and design authorship. Additionally, Allen led on project development through drawing, and Smout led on technology, fabrication and manufacturing.**





## Introduction

This environmental architectural design research examines themes of climatic and geographic processes. It focuses on how conservation landscapes enable the production of environmental architecture, especially focusing on the potential for hydrological technologies to reflect the specific qualities of the site, and to generate new experiences of a conservation area, and sustainable design. Two landscapes were the site for these explorations; the Spanish island of Lanzarote, and the River Severn and Severn Estuary. The designs concentrate on their natural resources and their use and preservation. These architectural proposals expose the distinct cultural, geographical and geomorphological qualities of the landscapes, and offer new modes of 'conservation' to the visitor. In these sites architecture is conceived as an active component of the landscape. [fig. 4]

### **Neo-natures**

Three designs – 'Ground Cloud', 'River Reversed' and 'Current Accumulator' [fig. 3] – propose a technological topography interposed into the lava fields and ash pit sites that dominate the island of Lanzarote. Lanzarote is the most easterly of the Canary Islands, sitting in the Atlantic 120km off the African coast. As a whole island UNESCO Biosphere Reserve, Lanzarote benefits from its association with the Man and Biosphere Programme (MAB), which informs governmental strategies towards the island's use of its natural resources.

The island's vulnerability to the effects of climate change threatens its unique biodiversity and its ability to manage the consequences of mass tourism. [fig. 5]

Each design uses and adapts emerging and dormant environmental technologies and vernacular processes, imagining and re-establishing the surrounding environment as an energy source for the architecture that inhabits them.

### **Envirographic techno-natures**

The project is inspired by the complex arguments of providing 'clean energy' for the UK. (The UK has committed to reducing its greenhouse gas emissions by 80 per cent by 2050 and producing 15 per cent of energy from renewable sources by 2020. In order to meet the 80 per cent target, it will be necessary to produce largely zero-carbon electricity by 2030). This 'clean energy' comes at the potential detriment of natural habitats of scientific and local significance. The project takes the form of photographic site studies followed by the design of instruments which were used on a field study trip to the River Severn. The Severn is a natural resource that has for centuries been a source of food, water, communication and power for the communities through which it flows. It forms a kind of living infrastructure fused to the built environment through the engineering of canals, bridges, water and, particularly for this project, the potential of hydropower.



4

**3 (previous page)**  
**Current Accumulator.**  
**Environmental**  
**architectural design**  
**for Lanzarote.**  
**Drawing in pencil**  
**and ink on a halftone**  
**print with digital**  
**colour overlays.**  
**841mm × 594mm**

**4**  
**Fundación César Manrique,**  
**Lanzarote**





Field studies informed the design of two architectural proposals – the ‘Instant Islands’ and the ‘Severn Lesser Bore Maker’ – which were conceived when the latest in a long history of hydropower proposals for the Severn Estuary were

under consideration. Both proposals are sited in an imagined landscape where the natural tidal processes and specifically the tidal bore would be interrupted by the construction of a hydropower barrage across the river. [fig. 1 & 2]

## Aims and Objectives

This research examines how specific conservation landscapes generate the conditions for experimental modes of sustainable architectural design. It sets out to examine:

1. How specific protected geological/land resources of a site inform sustainable architectural technologies.
2. How these technologies reflect specific human cultural qualities of the site.
3. How hydrological modes of energy reflect these conservation sites, and generate site-specific architecture.
4. How these enable new experiences of the landscape by visitors/users/tourists.

**6  
Jameos del Agua  
(by architect  
Cesar Manrique,  
1968) is a series  
of interconnected  
lava tubes and  
bubbles that has  
been transformed  
into public spaces,**

**including a bar and  
nightclub, swimming  
pool, gardens and  
an auditorium. The  
site is one of the  
seven Centers of Art,  
Culture and Tourism  
(CACT) which protect  
the island’s natural  
and cultural heritage.**

# LANZAROTE, A CHANGING CLIMATE THE 'ENVIROGRAMMIC' RESPONSE

W. J. E. Mitchell's *Landscape and Urban Elements* (Chicago Press, 2002) explores landscape as an instrument of cultural force. On the opening page, the author makes compelling readings about the ambiguity and nature of landscape design. "Landscape is a natural force mediated by culture. It is both a negotiated and imposed space, both a quarter and a quartered, both a frame and what a frame contains, both a end place and its condition, both a landscape and the connectivity inside the package." These practices go a long way in defining the complexity of our relationship with landscape. However, including global periods of climate change in recent years has necessitated critical knowledge of the intricacies of human impact within the natural world.

Our research explores a design based approach to architecture, landscape and climate change in political, technological and artistic disciplines. Our work proposes that the built environment can develop a dialogue and engage with environmental influences by understanding the complex interaction of living and artificial systems.

Our proposal is a technological topography for the Lanzarote here fields and ask you to contextualize a changing landscape and one physiographic survey of the geographical conditions that determine the island landscape.

Lanzarote has freshly established the built environment as an active component in the re-creation of our experience of landscape. Through the island's overall governance of energy and climate landscape, it has acted as a model for managing development in a sustainable manner and shows how landscape can be critical in providing a contextualized or abstracted vision of nature's atmospheric and human.

Lanzarote is the only island in the world to be designated a UNESCO Biosphere Reserve recognized under UNESCO's Man and the Biosphere Program, which focuses on human development in cooperation and sustainable development. The island is well suited to natural resource management that allows its approach to conservation and sustainable development. The island is well suited to natural resource management that allows its approach to conservation and sustainable development. The island is well suited to natural resource management that allows its approach to conservation and sustainable development.

This field of stress and change response is presented from human observation and therefore acts as a living laboratory for the study of slowly changing time and space. To protect this fragile environment, the island has developed a series of measures: nature's experience of the landscape to the people there. The visitor's experience is a geographical time series that slowly unfolds, three views of the island's face and biodiversity of nature. In this design process, these represent environmental, the General Assembly, the River Restored and the Grand Canal - use and shape emerging and diverse environmental interventions and restorative processes to establish the surrounding environment as the architecture's energy source. This also demonstrates the landscape cycle - the model of the movement of water above, on, and below the surface of the earth. Global climate change scenarios for the variety of water, drought and desertification, and currently more flooding and sea level rise, reflect the complexity of biological processes and their role in environmental activity.

In 2006, the International Union for the Conservation of Nature (IUCN) reported climate predictions for the Arctic, Alaska and the Canary Islands of 0.6°C on land and 2.2°C in comparison to a decline in the rest of the world's oceans. While the island's vulnerability to climate change is compounded by both the island's high rates of tourism and land use - which means that sea level change will affect a large proportion of land surrounded by its relatively small size. This makes the ability of plant and animal species to relocate successfully into suitable local environments.

Each of the three designs for Lanzarote - the *Green Architecture*, the *River Restored* and the *Grand Canal* - explores the tangibility of architecture and physical form and phenomena that are inherent in the local and global environment. We have shown Lanzarote as a test case for these conceptual processes to better illustrate physical and cultural context allow us to contrast and suggest political and geographical interventions to better illustrate the synthesis between the natural and the synthetic worlds. They are designed to challenge emerging architecture as an art form and to explore a positive and responsive interaction between the built and natural environments.

We need our observations to provide a heuristic context for the understanding and translation of architecture as an ecological system that can function through systems of environmental sustainability for the future of urban and rural landscapes.



## ANNUAL AVERAGE RAINFALL AND TEMPERATURE



## ANNUAL AVERAGE WIND CHART



## TOURIST EXPERIENCES

- Misador del Rio**  
A series of interconnected lava tubes and hollows that have been transformed into public spaces such as a bar/restaurant, swimming pool, gardens and an auditorium.
- Janero del Agua**  
A series of interconnected lava tubes and hollows that have been transformed into public spaces such as a bar/restaurant, swimming pool, gardens and an auditorium.
- Castro de San Vito**  
The 'Great Castle' was part of a 14km long lava tube which formed 3,000 years ago when *Montaña La Corona* erupted.
- Montaña del Fuego (Fire Mountain)**  
The volcano responsible for the eruptions that have devastated large areas of the Lanzarote landscape are now protected in Timanfaya National Park. Regular programs, a coach-drive route through the preserved volcanic landscape, and a restaurant with a sunset view that uses the heat from the volcanoes below are used to educate tourists about the history of the island.

## WIND AND CLIMATE WEATHER

- WIND**  
Projected increase in wind speed and more high pressure weather conditions, including tropical storms by 2050.
- TEMPERATURE**  
By 2050 land temperatures are projected to have risen by 2°C.
- HEAT**  
1-2% increase in humidity projected over next years.
- SEA LEVEL RISE**  
Projected sea level rise of between 0.5-1m by 2050.

Please note: All climate change projections taken from Joint Species Club Researchers, 'Climate Change Strategy of the Canary Islands' Report from the Faroese Diet and its Consequences. Evidence: Strategies to Counter Climate Change and Biodiversity Loss. Copenhagen, 09 July 2010. pdf available from [www.environmental.eu](http://www.environmental.eu), accessed 08 January 2012.

## Questions

1. How do landscape management and resource preservation provide access to new sustainable architectures and experimental environmental technologies?
2. How do these technologies and design interventions reflect the specific cultural context of occupation of protected landscapes?
3. How can the hydrological qualities of the site be expressed as a sustainable architectural design response?
4. How do these architectural interventions allow users to reinterpret and experience landscape in previously unimagined ways and how do they function?

## Context

### **Site-specific conservation conditions**

#### a. Lanzarote

Site-specific climates and their role in environmental design: Despite the island's relatively small size, there are five distinct microclimates from coast to coast that range from sub-tropical to semi-desert. Moreover, seasonal shifts in wind direction replace the cooling north-easterly trade winds with the hot and dry 'Calima' from Africa, which regularly causes temperatures to peak and smothers the island in a fog of Saharan sand. The design harnesses and reveals these varied conditions.

The harsh climate has generated unique agrarian landscapes which are themselves a tourist attraction (Thomas 2004).

Cultural knowledge: Cesar Manrique, artist and architect (1919–1992), was key in identifying and reinterpreting the experience of Lanzarote's natural landscape via architectural and sculptural form. In 1972 he compiled a photographic inventory of the significant aspects of Lanzarote's traditional architecture in which he made taxonomic connections that allied vernacular architectural form directly with the island's geological topography (Manrique 1974).

His subsequent strategies to develop Lanzarote's significant geographical sites as tourist destinations led to the design, over a 20-year period, of the seven Centers of Art, Culture and Tourism (CACT) sites. [fig. 6] These sites use architecture as a demonstration and augmentation of the aesthetic qualities of the geological landscape and greatly contribute to its reputation as a holiday paradise. Manrique's aim was to protect the island's natural environment from development; to create an environment that is a prototype for eco-tourism. He was also pivotal in the implementation of the Island Zonation Plan (PIO 1991), by which the island's council, the Cabildo de Lanzarote, imposes strict and prescriptive policies on building and the spread of mass tourism on the island.

UNESCO designation: Lanzarote is established as an experimental territory for sustainable tourism, an approach derived from both environmental and aesthetic principles (see Jimenez 2012). In 1993 it was designated a UNESCO whole island biosphere and classified under its Man and Biosphere (MAB) programme. This categorisation relates to the conditions that enable sustained economic development and land use consistent with the conservation of natural resources and ecosystems. [fig. 7]

#### b. Severn

The Severn proposals are inspired by the complex arguments for and against harnessing the River Severn's tidal power as an energy resource, and informed by the Severn's critical relationship to natural ecologies and local communities along its banks. The river provides water for domestic, agricultural and industrial use. It enables commerce via ports in the estuary and upstream such as Bristol and Sharpness.

The river's large tidal range has generated a long history of unbuilt barrage and lagoon proposals to harness it for tidal power, beginning in 1849 when engineer Thomas Fulljames proposed a barrier from Beachley to Aust (see fig.19). Following a government feasibility study during 2008–10, a number of publicly funded projects have looked at a range of tidal technologies in several locations. Since these design projects were conceived, new proposals have been initiated by Hafren Power who have restarted consultations for an 18km barrage between Brean in England and Lavernock Point in Wales (Hafren 2012). [fig. 8]





8

**8**  
 The Severn tidal bore is the second highest in the world and a spectacular natural phenomenon, traveling upstream as far as 40km at an average speed of 16km per hour and often reaching up to 2m in height. The best times to view the

Severn Bore are during the highest tides around the autumn and spring equinoxes. It can be seen along the lower lengths of the river, downstream of Gloucester, and is best viewed at one of four viewing points between Sharpness and Maisemore.

**9 (overleaf)**  
 Prototype 'Meniscus' model: An experimental model topography designed as an investigation of refraction, reflection and surface tension, through a careful composition of

translucent and reflective materials. Light is directed through the meniscus of water, a bi-convex lens and via a large refractive solid suspended below a notional horizon.





10



11

**10**  
Maquettes for the  
'Meniscus' models  
transparent block.  
The form was  
eventually used  
to create a negative  
mould for a positive,  
clear resin cast.

**11**  
The deep resin  
cast block acts as  
a transparent and  
refractive solid upon  
which the rest of the  
model is mounted.

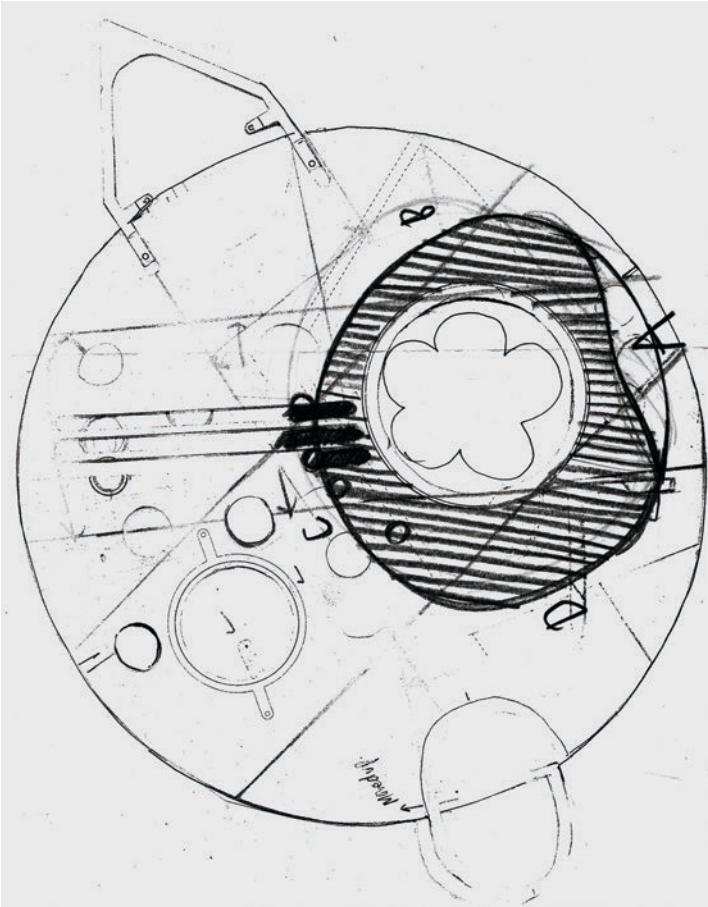
However, environmentalists have also made strong arguments against the construction of a tidal barrage. These arguments point to the loss of significant ecosystems, bird and fish habitats, and the danger to river and marsh flora and fauna caused by altering the flow of the river flow and the levels of the high and low tides.<sup>1</sup> Rotating turbines in the river flow also pose a danger to fish. Although a barrage would offset its 'material' cost (from procurement of aggregates and construction emissions) within its lifetime, environmentalists argue that this renewable energy source is less sustainable than it might seem. The barrage's cyclical energy output would require significant 'load-following' via the construction of dedicated coal-fired power stations (see Friends of the Earth Cymru 2007).

### **Demonstrating ecological and climate change information**

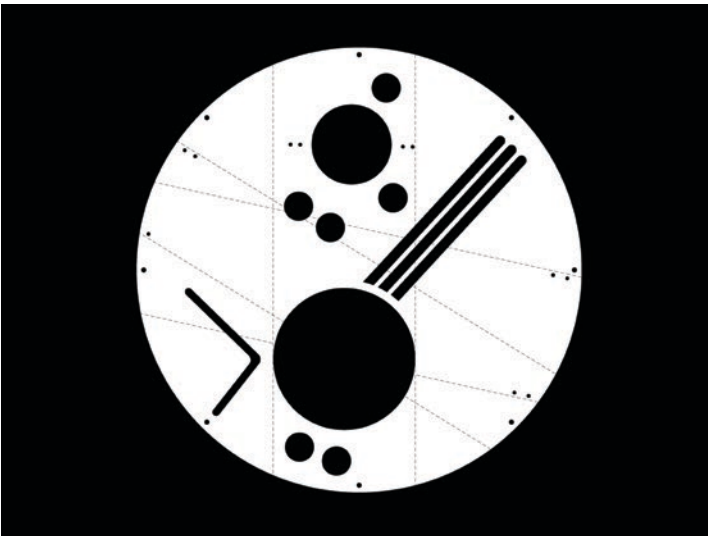
The demonstration of climatic and ecological information in data form can be problematic in relation to its interpretation both by the scientific community and by lay audiences. Architecture and other art forms can be critical in translating the relevance of scientific information (see Hamblyn and Callanan 2011). Visual demonstrations, working models, scaled representations and mock-ups in a simplified format can reveal or provide a more powerful expression than numeric statistical information. [fig. 9–12]

In 2008, the International Union for the Conservation of Nature (IUCN) reported devastating climate predictions for Lanzarote. Its vulnerability to climate change is compounded both by the island's high ratio of coastline to land area – which means that sea level change will affect a large proportion of landmass – and by its relatively small size. This reduces the ability of plant and animal species to relocate successfully into suitable local environments. Each of the three designs for Lanzarote – the Current Accumulator, the River Reversed and the Ground Cloud – explore the tangibility of technology, and physical laws that are inherent in the local and global environment. The designs use visual languages to describe the climate and environmental science to both specialists and lay audiences: for instance, viewers are able to observe the change of states of water from ephemeral vapour to flowing river and back again, and to see this manifest in lichen speciation, heat haze and power generation. [fig. 13]

1. The Severn Estuary and large areas of the river are protected under both the Habitats Directive and Birds Directive as Special Protected Areas (SPAs) and Sites of Community Importance (SCIs) designated by the Europe-wide network of 'Natura 2000' legislation.

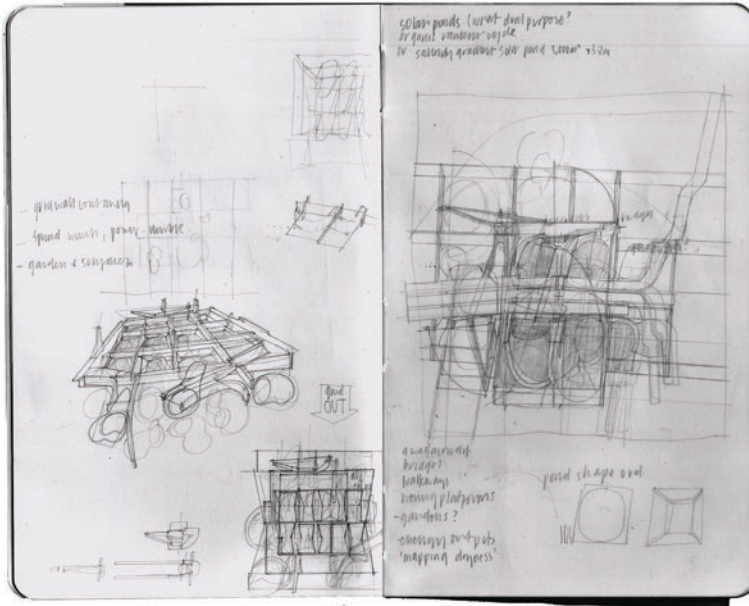
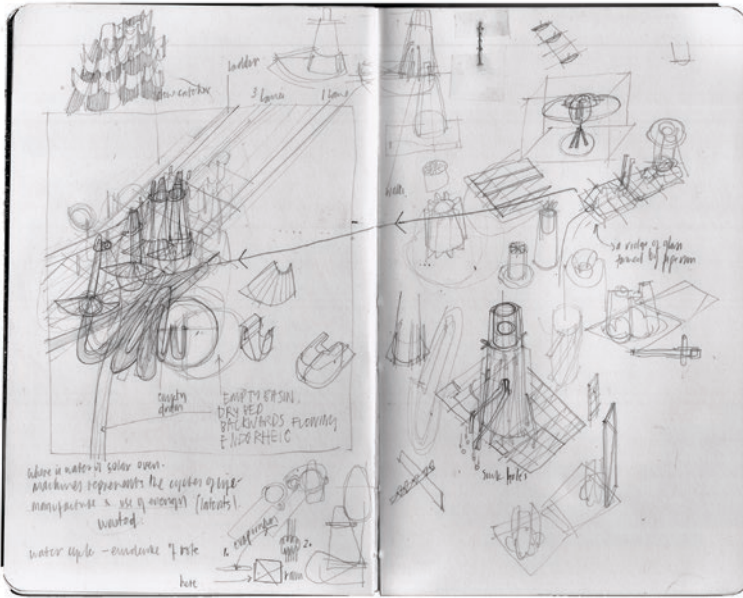


12a

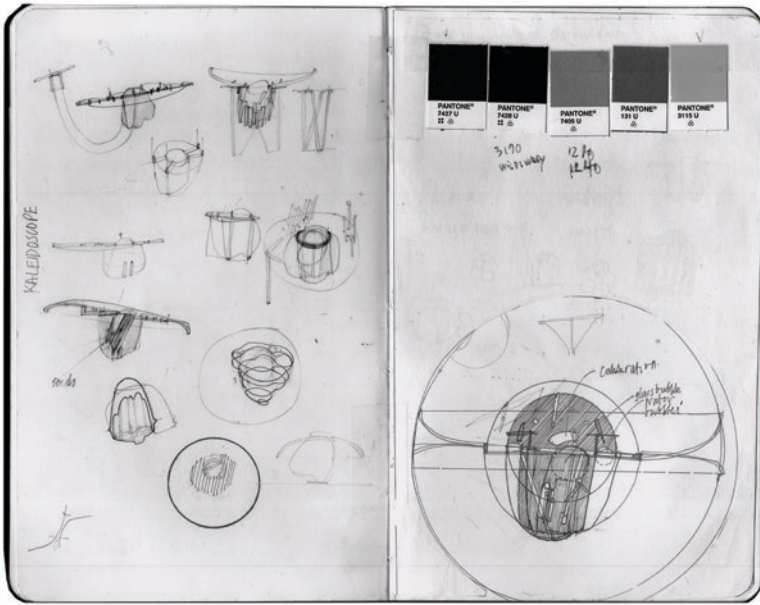


12b

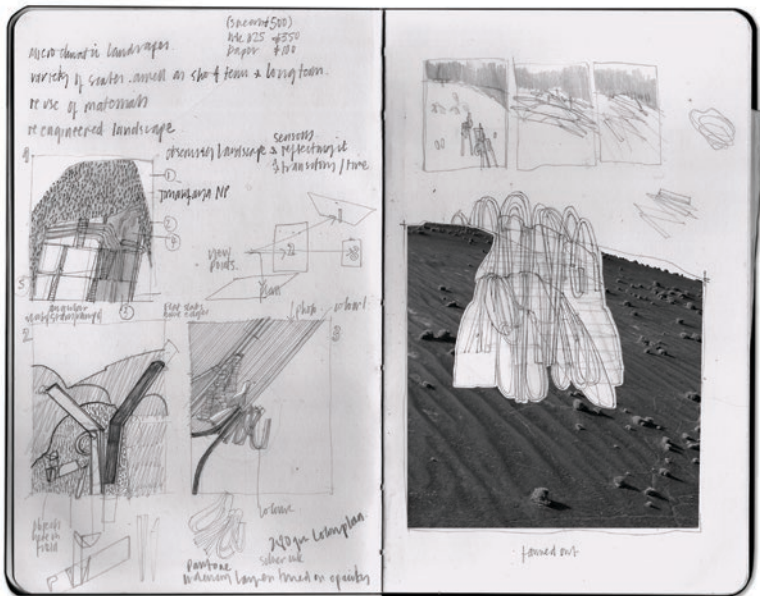
12  
Sketch designs for the 'Meniscus' model, in particular the model's surface topography which integrates both glass and water lenses and calibration devices



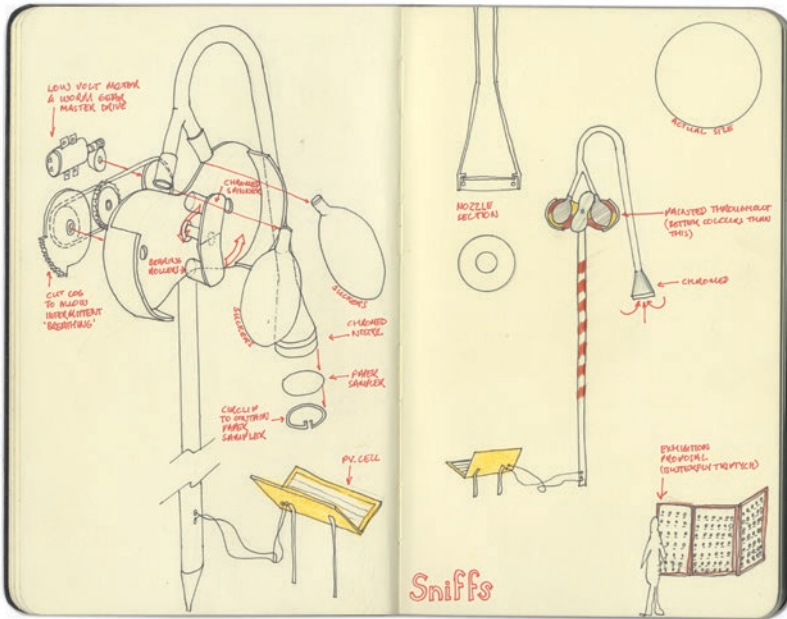
13  
**Sketchbook studies  
 for the Meniscus  
 model and each of the  
 Lanzarote proposals**



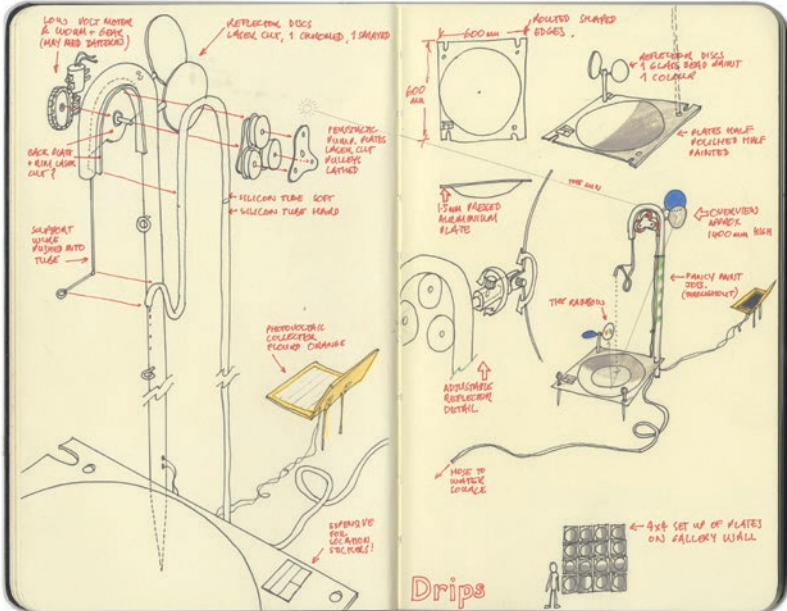
13c



13d



14a



14b

14 Sketchbook studies of the Envirographic instrument design



## Methods

### **Understanding landscape management and preservation of resources**

#### Envirographic Instruments:

A pair of 'envirographic' instruments were designed that borrow from the visual language and instrumentation techniques of environmental and landscape surveying equipment such as the Astrium 'eNose', which samples air in extraterrestrial environments, and evaporation pans, which are used in meteorological surveys to integrate the effects of several climate factors. They aim to contribute to our understanding of site conditions by measurement and observational analysis. The instruments were used in a study trip in July 2011 from the Severn's source in the Cambrian Mountains of mid Wales through to the Severn Estuary and the Bristol Channel, where they were deployed to taste, smell and record measurable as well as ephemeral and ambient qualities of the environment. The river undergoes constant monitoring and analysis for water quality, flow rate and level, as well as biota. [fig. 14–17]

The Envirographic Instruments critique the way in which sites are interpreted and the way measurements are used to provide definitions that prescribe landscape types, their resulting designation and their subsequent use. They attempt to show how environmental phenomena and

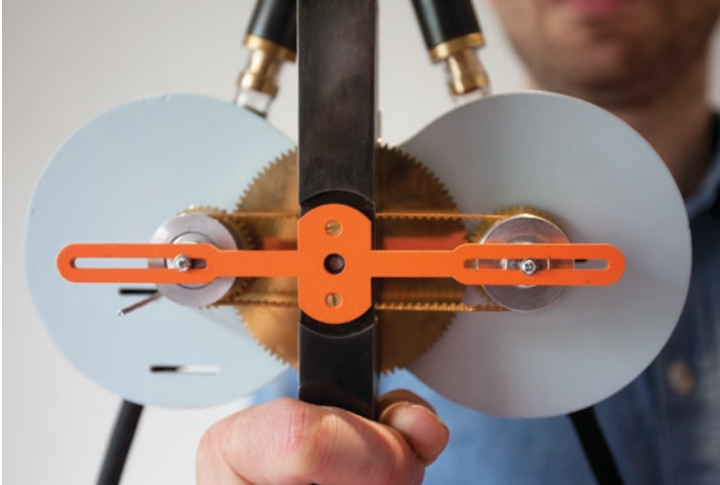
ecological scenarios can be visualised in data form and vice versa. Documentation of their design and use forms a significant element of the project. [fig. 18]

### **Generating experimental technologies and design interventions that engage with the specific cultural contexts of occupation in the land**

#### a. British landscape designations

A wide range of statutory and non-statutory conservation designations protect a substantial area of the Britain, its wildlife, natural landscapes and cultural artefacts by informing local and national policy making. These designations include those that aim to quantify the values of natural space and the qualities of natural beauty that are both aesthetic and cultural, for instance, in relation to industrial heritage sites, and bucolic agricultural landscapes.

The Instant Islands project is sited at Newport Wetlands, a Royal Society for the Protection of Birds (RSPB) reserve established in 2000 to offset the depletion in tidal wetlands wildlife habitats that resulted from the construction of the Cardiff Bay Barrage. The Severn Lesser Bore Maker is sited at Garden Cliffs, Westbury on Severn, a geological Site of Special Scientific Interest (SSSI). [fig. 20]



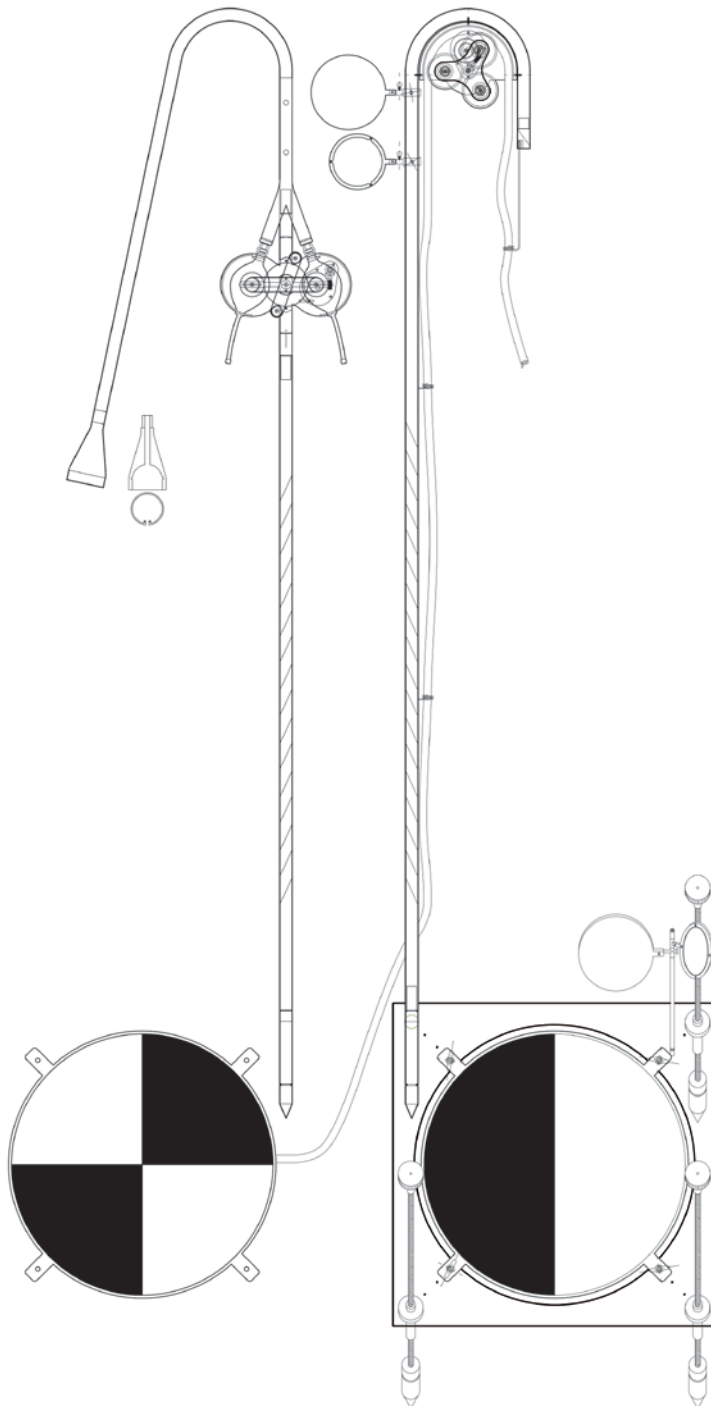
15a



15b

15  
Front and rear detail  
of the Air instrument  
showing twin gland  
arrangement

16  
Envirographic  
Instrument:  
Air and Water  
Technical drawing





17a

17  
**Field studies. Setting  
up the instruments in  
landscapes adjacent  
to the River Severn**



17b

**18 (overleaf)**  
Photographic surveys  
of the Envirographic  
Instruments at selected  
sites of interest along  
the River Severn.  
Commissioned by the  
Nevada Museum of Art



18a



18b



18c



18d



18e



18f





18g



18h



18i



18j



18k



18l



19

19

**This banana plantation greenhouse in northern Lanzarote is a rare example of intensive farming which is generally impractical due to its excessive irrigation demands.**

### b. Responses to Cesar Manrique and the Zonation plan

The project responds to Manrique's photographic techniques of recording human-nature relations. In addition, it recognises that Manrique's use of architecture as a demonstration and augmentation of the aesthetic qualities of geological landscape was pivotal in the implementation of the Island Zonation Plan, which controls the development of Lanzarote's built environment by imposing strict and prescriptive policies on building and the spread of mass tourism. The Plan led to the UNESCO MAB designation, which further supports and controls whole-island development strategies by imposing a moratorium of hotel development and supporting mechanisms for eco-tourism.

### c. Potential of landscape as a resource

In the context of Lanzarote and the Severn, the identity and value of the landscape is measured by a combination of aesthetics and utility. The Severn River and Estuary provide water for drinking, agricultural irrigation and industrial uses. The river is canalised and locked to provide transport by water and to support commerce. It may also soon become the site for energy production from tidal power.

The potential of landscape as a productive resource for local communities is historically anchored. However, the environments of Lanzarote and the Severn both integrate and intertwine

practical performance qualified by aesthetic values, which is a more recent development. In Lanzarote, thousands of acres of land are covered with a black layer of volcanic ash sculptured into hollows and surrounded by ridges of semicircular lava brick walls. This tourist curiosity is an agricultural necessity. The dry farming technique cuts water loss by as much as 75 per cent to nurture plant growth in otherwise inhospitable environments. The process uses volcanic stone mulch (Pearce, Sep 2006) called 'picon', of which there is a limited supply. It is predicted that the resource will be depleted in 15 years and this will have a marked effect on both agricultural and tourist industries. [fig. 19 & 21]

## **Prototyping hydrological responses**

### a. Hydrological technologies and sustainable processes

The Lanzarote designs adopt technologies that exploit climatic conditions in the transformation of environmental energy and natural resources. These are used in a way that makes the surrounding environment visible and demonstrates meteorological processes. They particularly demonstrate aspects of the hydrological cycle – the model of the movement of water above, on, and below the surface of the earth – and its role in environmental activity.

Fog nets: Air dehumidifying technologies known as fog collectors and fog fences (Marzol et al. 2010) can be deployed in arid or semi-arid territories with onshore prevailing winds that flow air currents over steeply rising inland topographies. These technologies provide water for agricultural and reforestation programmes where the topography and fog density is at an optimum. The most common form of fog collector is a mesh curtain that intercepts windblown fog droplets and transfers them by gravity into a reservoir at a lower level; each collector can provide water in substantial quantities (4.5–5.5litres per m<sup>2</sup> per day, cf. fogquest.org<sup>2</sup>). Trialling began in the Haria region of Lanzarote in 2003 (Pearce, Aug 2006) but the island's council has not sustained funding for the project.

In the Ground Cloud design [fig. 23 & 24] an array of nets is distributed up the hillside in tensioned frames. These frames are initially structured and stable, and collect dew as night falls. When air temperature, weight, humidity and engineered intolerances conspire, the frames 'fail' and shake and jerk into new configurations. A cloud of droplets is instantly airborne and an 'atmosphere' of

vapour is momentarily created. Microclimates and even verdant environments are created where the moisture falls. The slopes are inhabited by the island's endemic species of lichen as microclimates of accelerated speciation are established.

Solar ponds: Dynamic ocean topography is the model of currents flowing in complex patterns around the globe. This movement, influenced by many factors such as wind, heat, salinity, gravitational pull and the topography of the sea bottom, affects climate, biodiversity and the environment even far inland. Lanzarote is affected by the Canary Current, a cool and nutrient-rich branch of the North Atlantic Current that is responsible for the enhancement of West African fisheries. Solar energy can be harnessed for power generation via solar ponds that act like miniaturised oceans and exploit extreme gradients of salinity and temperature to generate power. This energy source is typically used in developing countries to power local industry on a small scale.

The River Sever is the UK's longest river, stretching 220 miles from its spring source in the Welsh Black Mountains, a site of rivers and fishery. Though the Sever suffers from its periodic inaccessibility to a wide range of users, through part and flood zones of the Sever Channel.

It has long been a source of inspiration for large-scale energy resource, and during the last 50 years numerous proposals for a tidal barrage between the English coast and Welsh coast have been raised and considerable expense has been borne to advance their viability.

The building of such a structure would not only have large fields of engineering benefit and also would create new jobs. Good protection, better creation and more improved harvesting tidal energy. Recent an amount of climate change and the risk of sea level rise, it would also provide a home to the local economy by one of the construction, tourism and infrastructure industries.

The Sever's large tidal range provides a unique environment for local wildlife, as well as large runs of river tidal habitat in its estuary that are potentially at risk from the barrage proposal. The key environmental issues associated with the building of a barrage include:

- Reduced river and river tidal habitat, flooding mechanisms and displacement of winter birds
- The proposed barrage also might cause progressively making low tide rivers and high tide higher some of the area currently reserved for low tide would be permanently inundated, meaning that large runs of river tidal habitat that currently rely on tides will be reduced
- The passage and survival of fish
- All proposals for traditional barrages involve building a barrier across the river, which would not only impede the passage of migrating fish but also threaten their survival, potentially leading to the complete decline of species such as Atlantic salmon and trout
- Geomorphology
- Any tidal power scheme would remove energy from the estuary, and possibly cause fundamental changes to the way the estuary as a result. For instance, it is predicted a large sediment might be deposited (either on or outside near tidal habitats), or causing siltation near tidal habitats and leading to sediment infill and bed level changes, affecting water quality and flood defences

## UK ENERGY TARGETS

The UK aims to triple the capacity of electricity generation by the year 2020, ensuring a steady supply of energy to meet these challenges. The UK has committed to reducing its greenhouse gas emissions by 50% by 2020 and producing 15% of UK energy from renewable sources by 2020. In order to meet the UK's targets, it will be necessary to produce larger amounts of energy by 2020.

However, the proposal was shelved in 2010, following a UK Government feasibility study which first assessed the Sever's tidal energy potential, its viability as a renewable energy source, and its potential to meet the UK's energy needs, along with the high cost of implementation.

The Sever's tidal energy potential is estimated to be around 1.5 TWh per year, which is equivalent to the output of a large coal-fired power station. However, the Sever's tidal energy potential is estimated to be around 1.5 TWh per year, which is equivalent to the output of a large coal-fired power station. However, the Sever's tidal energy potential is estimated to be around 1.5 TWh per year, which is equivalent to the output of a large coal-fired power station.

This relationship was taken as a study for our design process. In 2010, before the Sever tidal energy project was shelved for later dates, our design team began to explore the idea of an integrated plan for energy, water, and flood risk. This plan is no longer substantially tidal, which will be a major focus of our work. The plan is no longer substantially tidal, which will be a major focus of our work. The plan is no longer substantially tidal, which will be a major focus of our work.

## TIDAL POWER TECHNOLOGY

Tidal energy utilizes the natural rise and fall, currents of tidal water flowing and creating natural forces along the shoreline. The energy is harnessed through various technologies by passing the water through turbines or turbines. The tidal energy generation goes through periods of maximum generation every six hours corresponding to the times of the tide.

The tidal range of the River Sever is as much as 14 meters in full spring tides and is the main focus of Sever tidal power proposals. In 2009 two different schemes with a combination of tidal technology were investigated. These included three forms of tidal energy technology: barrage, turbine, low head barrage and run forms of tidal stream technology tidal net and tidal fence.

## POWER GENERATION POTENTIAL

The recent Sever tidal power assessment would have provided a long-term, reliable, stable and significantly generated renewable energy source, helping reduce carbon dioxide emissions and contributing to the UK energy targets. On the conventional power generation, the Sever Barrage plan does not include the combination of tidal facts except for their construction, therefore associated very low carbon emissions with the proposal. The two middle barrage proposals, were produced to generate approximately 1% of UK energy demand, although there were concerns that the peaks in power generation as a result of the fluctuating tides may not coincide with peaks in demand.

## POSITIVE LOCAL IMPACT

As well as the benefits associated with renewable energy generation, large scale barrage would also create better, improve water conditions and provide the opportunity for new and old links between England and Wales. Not only would the barrage create flood defences and protect the Sever estuary from more erosion, it would also provide a boost to the local economy by one of the construction, tourism and infrastructure industries.

## ENVIRONMENTAL RISKS

The Sever's large tidal range provides a unique environment for local wildlife, as well as large runs of river tidal habitat in its estuary that are potentially at risk from the barrage proposal. The key environmental issues associated with the building of a barrage include:

- Reduced river and river tidal habitat, flooding mechanisms and displacement of winter birds
- The proposed barrage also might cause progressively making low tide rivers and high tide higher some of the area currently reserved for low tide would be permanently inundated, meaning that large runs of river tidal habitat that currently rely on tides will be reduced
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## ENVIRONMENTAL PROTECTION

The Sever's history has various legal dimensions in order to protect its unique environment. It is designated as a Special Protection Area (SPA) under the European Birds Directive, and as a Special Area of Conservation (SAC) under the European Habitats Directive. And to its importance of the European ecology listed in the country. As well as representing 7% of the UK's total population, it is also designated as a "natural" site of international natural importance. Currently these various environmental boundaries are shown in Figure 2009 (see).

The original plan of the Sever proposals had for over 1000 regulatory and scientific water bodies as well as a host of regulatory fish including Atlantic salmon and trout, shell and wetland areas of sediment and mudflats. The subtidal and intertidal areas of sediment and mudflats. The subtidal and intertidal areas of sediment and mudflats. The subtidal and intertidal areas of sediment and mudflats.

The various environmental legislation associated with the Sever Estuary, requires that any potential impacts to Natura 2000 sites arising from a proposed Sever Barrage should be subject to a formal assessment process called the Habitats Regulations Assessment (HRA), prior to approval being given.

## SCHEMES AND LOCATIONS

SCHEME	POTENTIAL SUPPLY	ESTIMATED COST	SHORTLISTED IN 2009
01 Otter Barrage	7.5% UK demand	£13.34 billion	No. Challenges are such benefits. Revisions for UK taxpayers. Not too many alternatives.
02 Tidal Fence	3.7 TWh/year	£6.66 billion	No.
03 Tidal Rod	1.0 TWh/year	£18.75 billion	No.
04 Churchill Tidal Turbine	0.45 TWh/year	£3.85 billion	No. Technology not fully developed. Not necessary to make the scheme viable.
05 Middle Barrage	7.8% UK demand	£23.5-26.9 billion	Yes. 2009. The government does not see enough habitat loss if none.
06 Osborn Tidal Lagoon	2.6 TWh/year	£3.44 billion	Yes. Best performing Lagoon. Revisions for benefits.
07 Middle Barrage	4.8% UK demand	£19.6-22.2 billion	Yes. Huge renewable site potential. It must be a good idea.
08 Tidal Fence	Unknown	Unknown	No.
09 Osborn Tidal Lagoon	Unknown	Unknown	No.
10 Osborn Tidal Lagoon	Unknown	Unknown	No.
11 Fleming Lagoon	2.3 TWh/year	£4.1-4.9 billion	Yes. Lower environmental impacts than the barrage scheme.
12 Sever Barrage	1.7 TWh/year	Unknown	Yes. Low cost of energy. Contribution to renewable goals.
13 Bealby Barrage	2.7 TWh/year	£3.2-3.9 billion	Yes. Low cost of energy. A high environmental impact.

## THE SEVERN BORE

From time to time, the Sever Bore is caused by the flooding of a flood tide as a result of a large and narrow shallow inlet due to the same small flow rate than the wave speed of the river further upstream. The Sever tidal bore is the second highest in the world and a spectacular natural phenomenon, running upstream as far as when at an average speed of 14km per hour and often reaching up to a single.

The best times to view the Sever Bore are during the especially high tides around the autumn and spring equinox. It can be seen along the lower length of the River Sever, downstream of Gloucester, and is best viewed at one of four viewing points between Shropshire and Malvern. In recognition of its tourist value, the UK Environment Agency has classified a river for its height and public interest on its website, along with a forecast.

The largest recorded Sever Bore was 610 metres high when the river reached a height of 2.8m (9.2ft). As such, attempting to surf the bore has become a regular activity for river surfing enthusiasts. If a change scheme was implemented into the River Sever, the Sever Bore would no longer occur.

# THE RIVER SEVERN: AN ENERGY RESOURCE





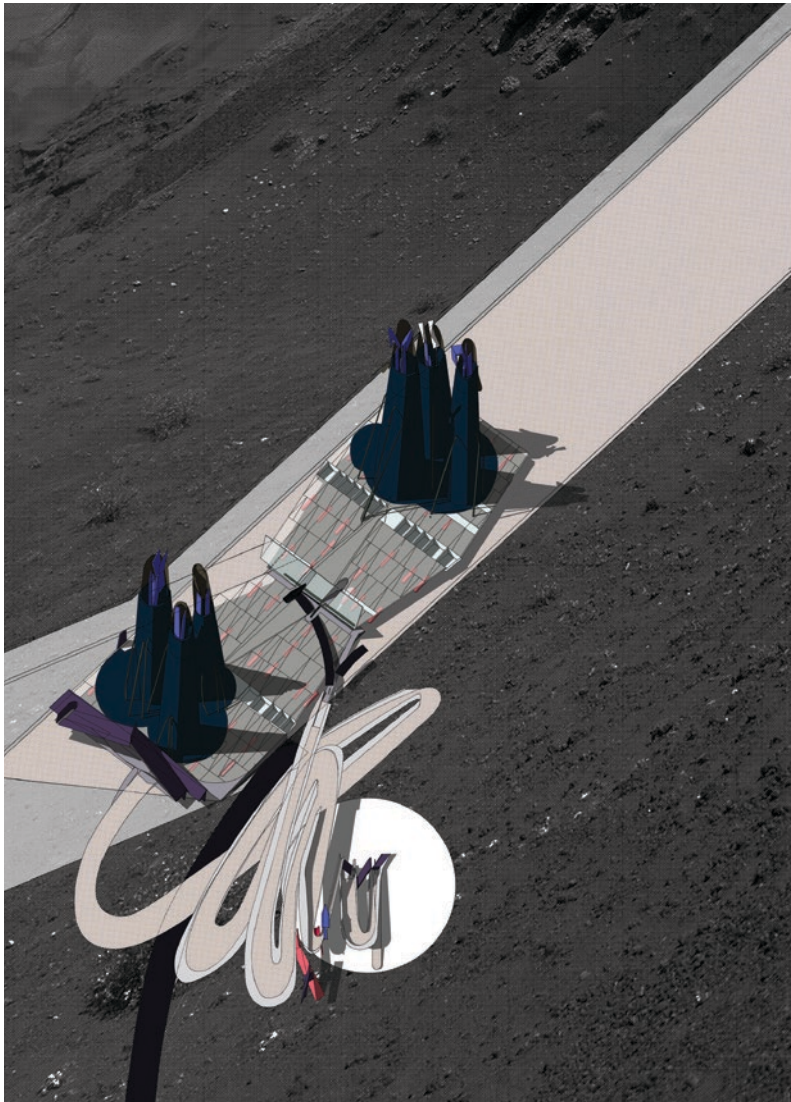
21

21  
 Le Geria vineyards, which cover approximately 50km of the island, are formed by thousands of semi-circular hollows, a dry farming technique called *enarenado*

which is unique to Lanzarote. The technique is designed to capture and retain as much of the island's scarce water supply as possible. Each 'socos' hollow harbours an individual vine

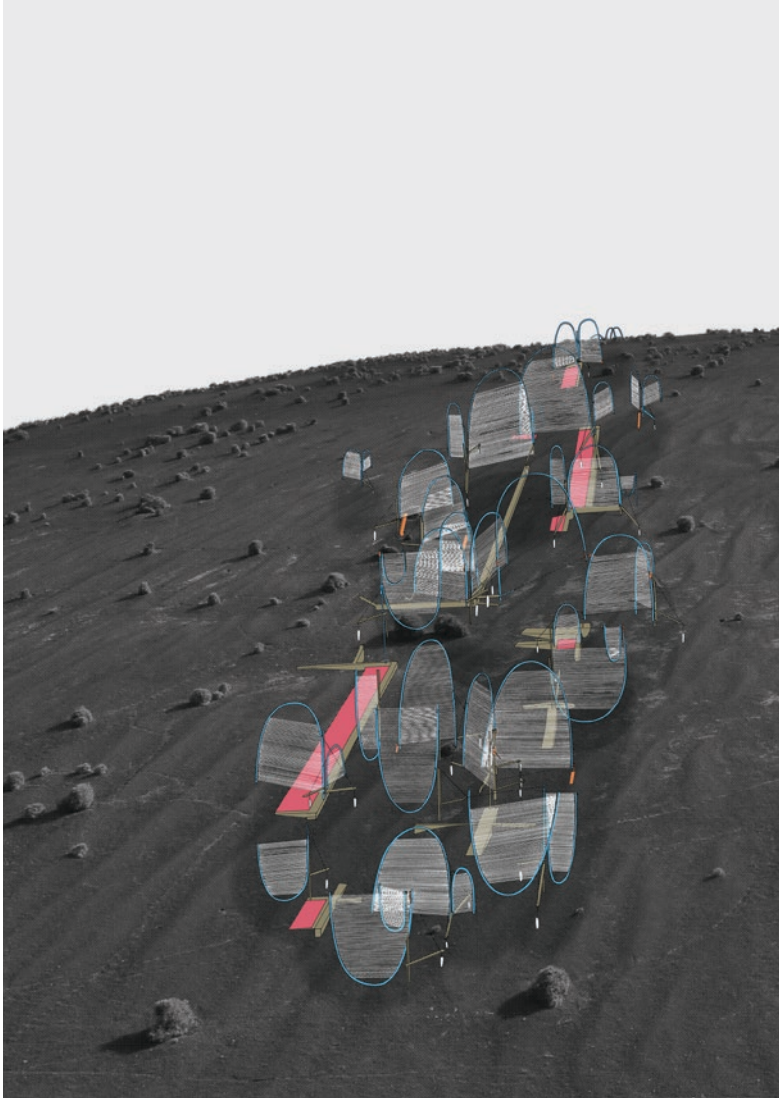
planted below the thick layer of porous black volcanic gravel known as *lappili* or *picon* which absorbs humidity and preserves moisture from morning dew by preventing evaporation.





22

**22**  
**River Reversed.**  
Drawing pen and  
ink on halftone print  
with digital colour  
processes.  
594mm × 841mm

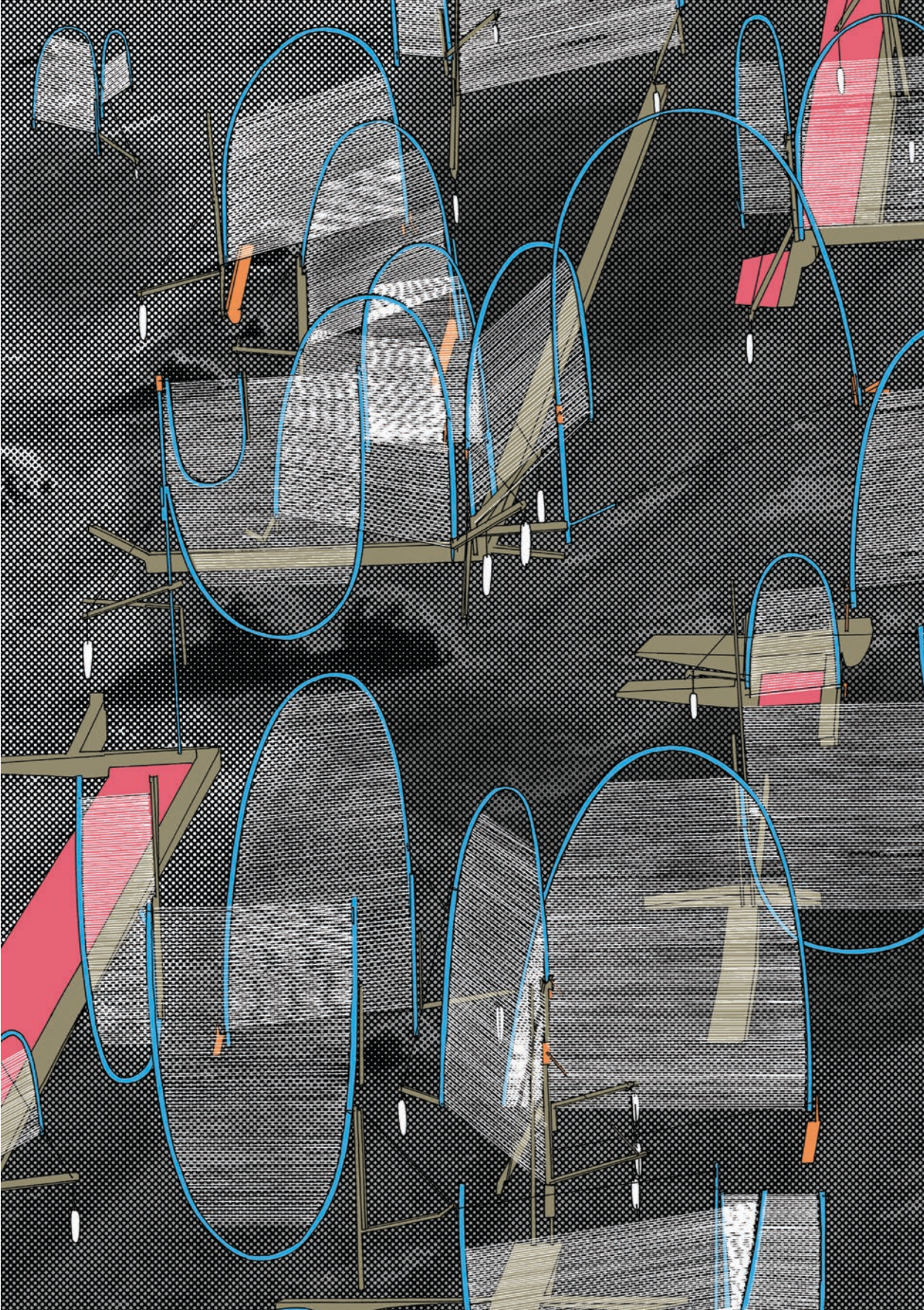


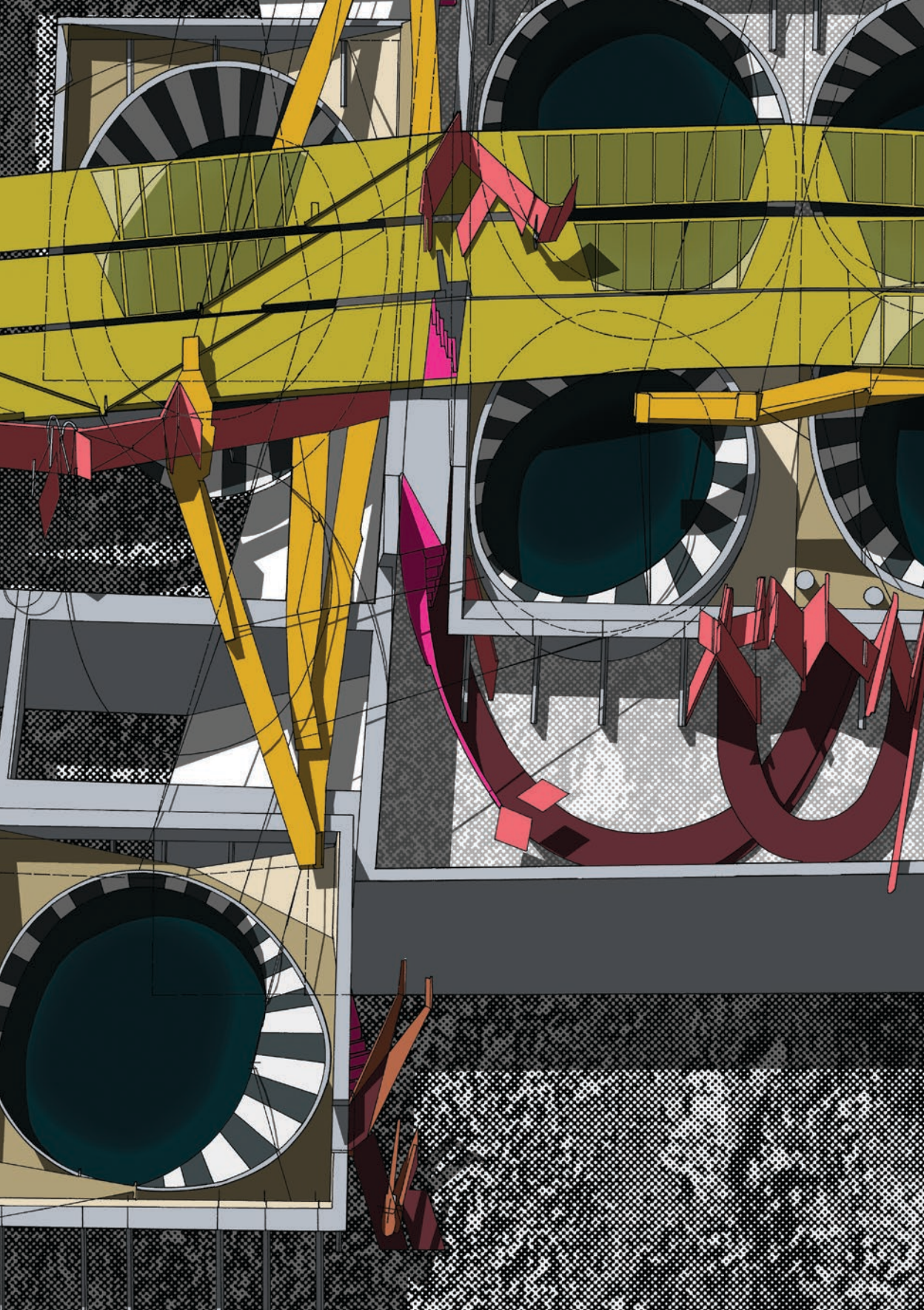
23

**23**  
**Ground Cloud.** Fog collecting nets are arranged upon the barren landscape. Pen and ink on halftone print with digital colour processes.  
 594mm × 841mm

**24**  
**Detail of Ground Cloud.** Unlike that of other Canary Islands, Lanzarote's topography is too low for it to take full advantage of the 'sea of clouds' that can provide orographic

precipitation, but around the northern hills, airborne water moisture can be harnessed by means of fog nets suspended high against prevailing winds.





In the Current Accumulator design [fig. 25] a landscape of saltwater solar ponds is connected by a network of cables and large tensioned armatures that store and transfer power. This is then gradually released as a continuous momentum acting upon the surrounding landscape.

Desalination: Lanzarote is a dry island, with no river or subterranean water sources. The island's indigenous architecture employs numerous techniques such as run-off collection systems and cisterns, and banked fields, cross terracing and check dams preserve water from rainfall. However, these methods are insufficient to provide water for the island's current population, swollen by tourism. Instead the island relies on imports of bottled water and desalinated seawater to provide a mains supply. Desalination is extremely costly, energy hungry and an unsustainable process. In Lanzarote 97 per cent of the water is delivered.

The River Reversed design [fig. 22 & 26] references the closed hydrological phenomena of 'endorheic' or salt lakes, where topography prevents drainage out to sea, and where instead the basin loses water by evaporation. It adopts the environmental technology of solar chimneys, where the updraft tower, more commonly used to provide ventilation, condenses water extracted by evaporation from a glass-covered saline pond. The tower has a reflective internal surface to multiply available light while absorbing radiation on its external surface to minimise

heat loss through its mass. The chimney therefore superheats the moisture-laden air to vastly increase the volume of air passing through the system and therefore the quantity of condensate collected.

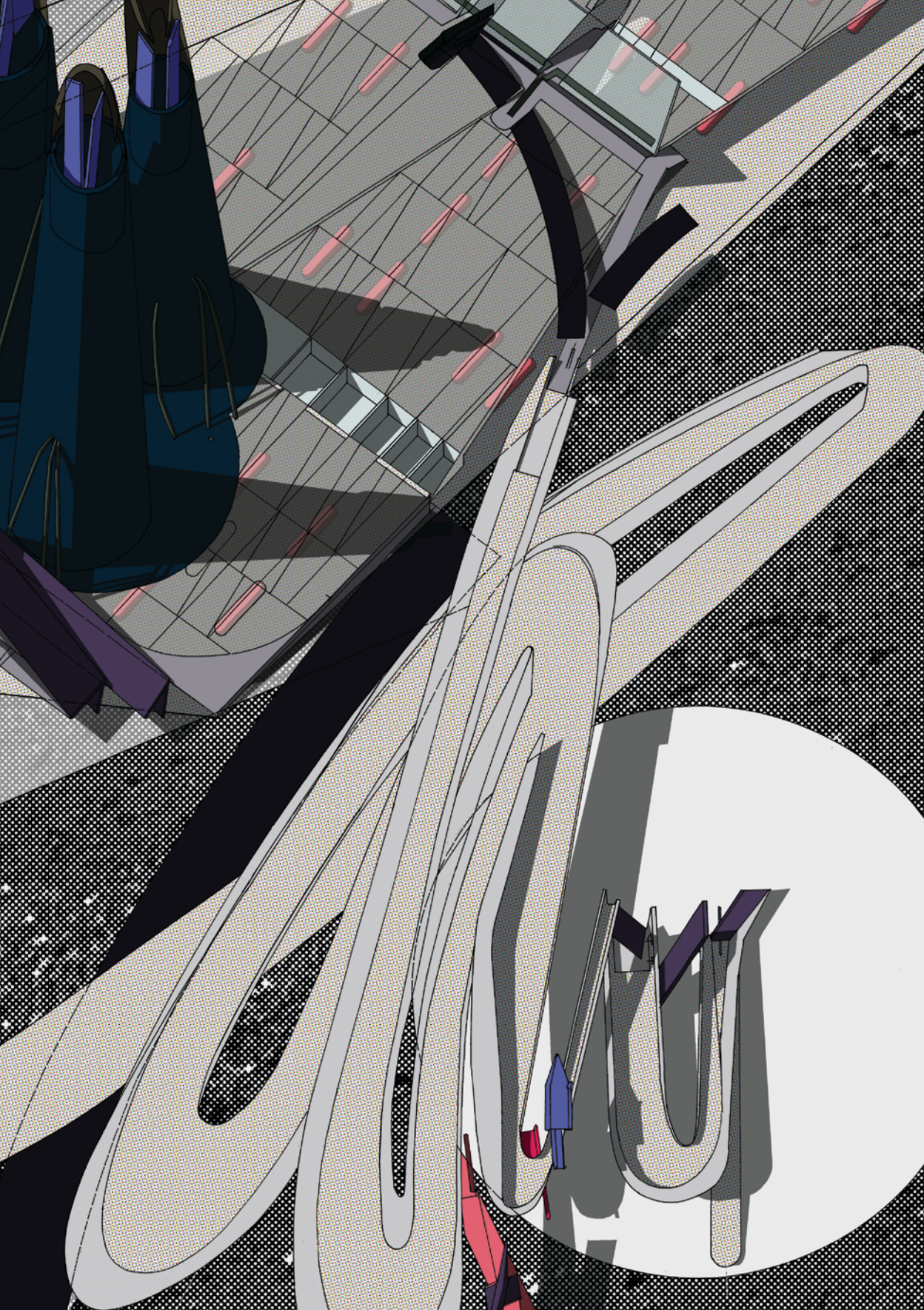
The surrounding landscape becomes a basin to the technological process. The emerging flow of fresh water is directed into a culvert cut from the surrounding rock landscape that transforms it into an artificial river flowing in a compressed meander through the site. The river is exposed to the sun's heat, while it also seeps into the concrete structure – the torrent becomes a stream, then a trickle, fractioning out minerals along its journey. Eventually just as the course reaches the basin the river is a dry, representing in reverse the hydrological cycle from rainfall to ocean. [fig. 27]

#### b. Post-barrage designs

Two design propositions are envisaged to provide environments that replicate and augment territories lost or altered by the diminished tidal flow of the river. [fig. 28]

The Instant Islands scheme provides a landscape of platforms that sit in the previously intertidal river shallows and mudflats on which migratory wading birds would have fed and wintered. The platforms are designed to contain silt which is scooped up from the flow of the river via a series of gates, jets and channels and settled in the platform's shallow bowl. The mud and silt habitats can be flushed out on a seasonal basis. [fig. 29–32]

1. FogQuest is a Canadian charitable organisation that runs rural water projects in sites where conventional sources of water are unavailable ([www.fogquest.org](http://www.fogquest.org)).



A walkway meanders throughout the platform landscape allowing visitors to observe the birds as well as revealing the hydrodynamic force of the river and the mechanisms by which it is controlled. [fig. 33–36]

The Severn Lesser Bore Maker attempts to recreate the spectacle and sensation of the Severn Bore with the aim of sustaining the touristic curiosity of natural phenomena. A bore producing tidal surge would be substantially reduced or even entirely lost if barrage or lagoon projects are put in place across the Severn Estuary. [fig. 37]

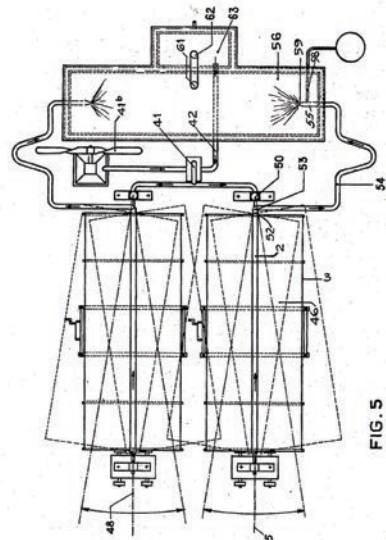
The Bore Maker is sited at the 30-metre mudstone Garden Cliffs at Strand, which are the highest feature along the river course. This vantage point is used to attain a panoramic viewpoint over the landscape. The height of the cliff is exploited to provide a head of water to activate the artificial bore process.

The Bore Maker is experienced by walking a series of pathways at the river level among a field of tilting platforms. [fig. 38 & 39] Turbines that sit in the river flow harness energy and this power is used to pump water from the river to the land to be stored in cisterns at the highest point on the shore. Water is held in large cisterns which are housed in tipping cradles. When sufficient water is stored the cistern cradle is overturned and the water released in a rapid flow. This energy is used to drag the river platforms down below the water. From the pathways the river appears to begin to swell and its turbulent surface evokes the power and lost performance of the bore.

c. Testing how these produce new ‘envirogram’ experiences of the land for users

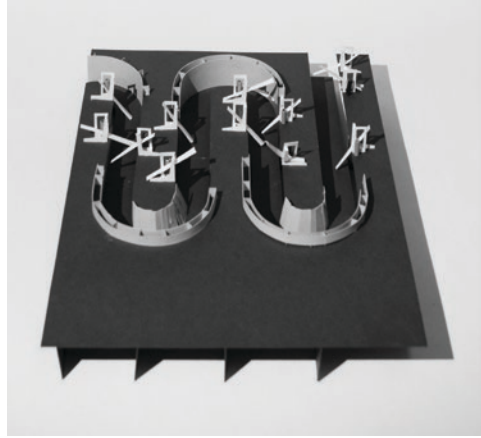
Farming, salt production and fishing were Lanzarote’s main socio-economic activities until the arrival of tourism in the 1960s. From this point the island has moved from a landscape of subsistence into an object of geographical and geological demonstration and spectacle. Productivity is overwritten as the island is conceptually reconstructed via model tourist initiatives towards a future of eco-tourism where the appeal of sunshine and beaches is exchanged for ecology, geology and culture.

Aug. 20, 1957 H. COANDA ET AL 2,803,591  
APPARATUS FOR PURIFICATION OF UNDRINKABLE WATER  
Filed April 27, 1954 4 Sheets-Sheet 2

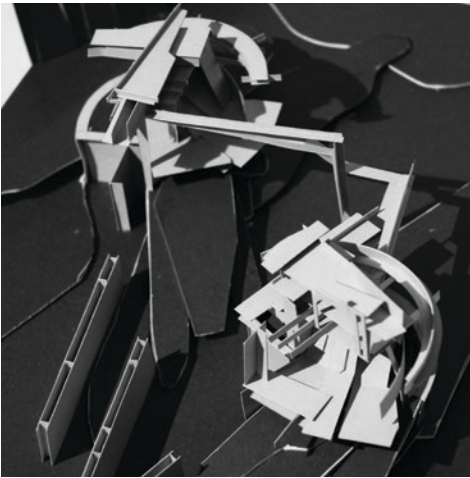




28a



28b



28c



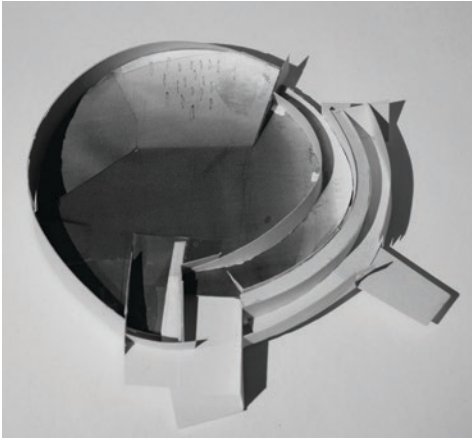
28d

**25 (page 42)**  
**Current Accumulator**  
 detail. The solar ponds slowly shift, rise, fall and rotate, mimicking the flows and cycles of ocean water and at the same time illustrating the potential of environmental forces.

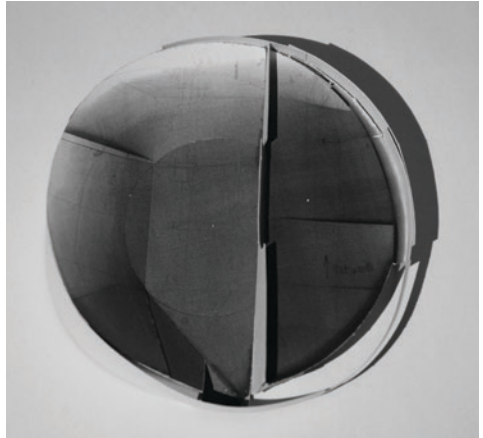
**26 (page 44)**  
**River Reversed**  
 detail showing the collection basin and artificial river course

**27 (page 45)**  
**Henri Coanda's**  
**'Apparatus for**  
**the purification of**  
**undrinkable water',**  
 which he devised and patented in the 1950s but which was never adopted for use.

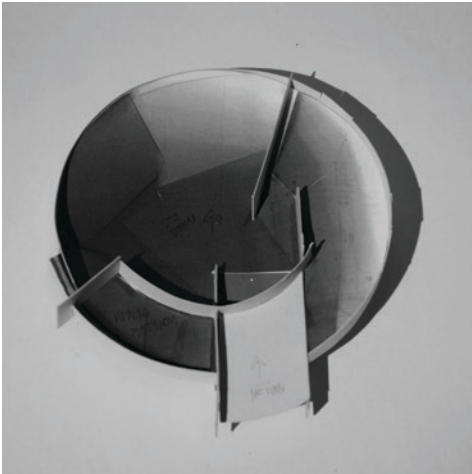




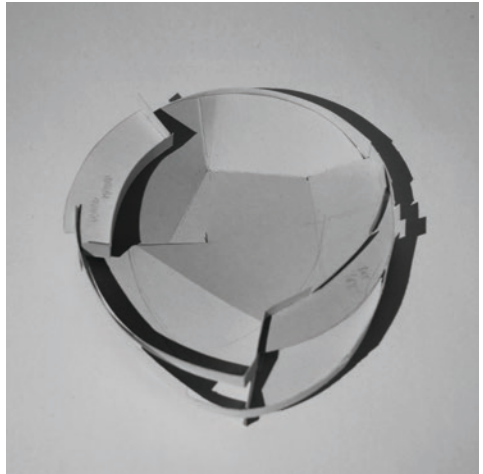
29a



29b



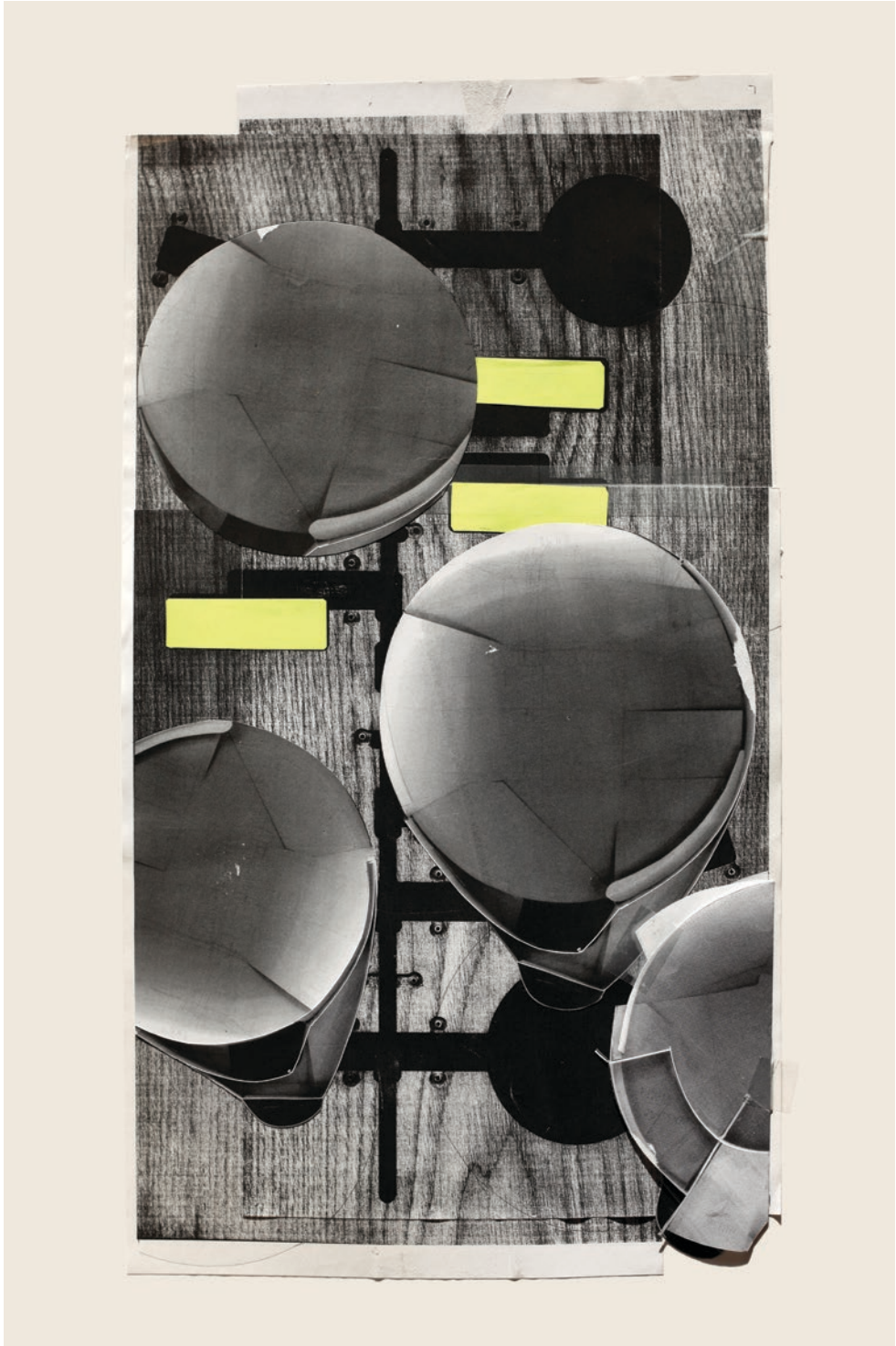
29c



29d

**28**  
Modelling responses to the post-barrage environments using weirs, canals, culverts and lock gates to explore flow

**29**  
Modelling to evolve the circular pan design. Gates and sluices control water flow into 15–20 metre diameter deep reservoirs and shallower pans where estuarine silt ecologies can be generated.



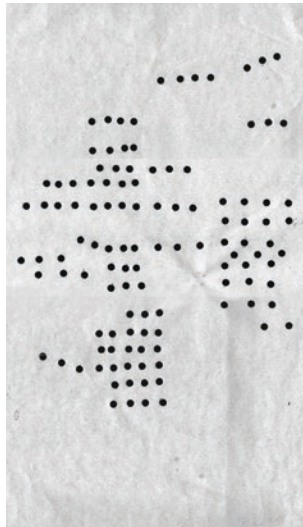


31

**30 & 31**  
The design process includes collage and composition studies via photocopy and montage that are interpreted into the dynamic model for the Instant Islands proposal.



32a



32b



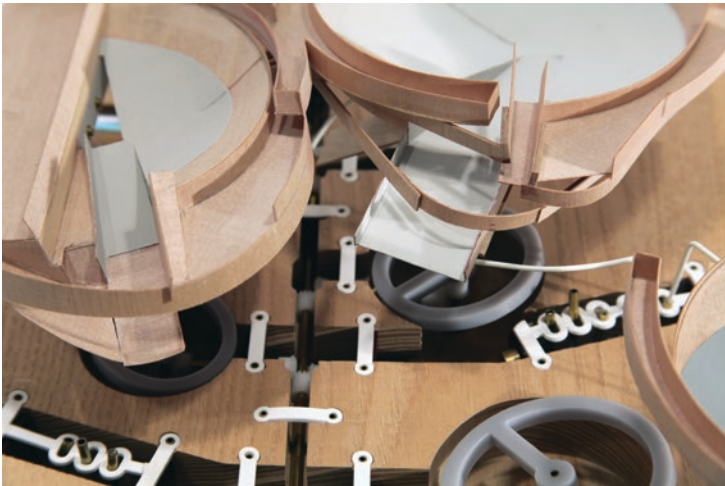
32c

**32**

**Templates and cutting patterns for the paper layer which is used to represent the flow and sediment in the river**



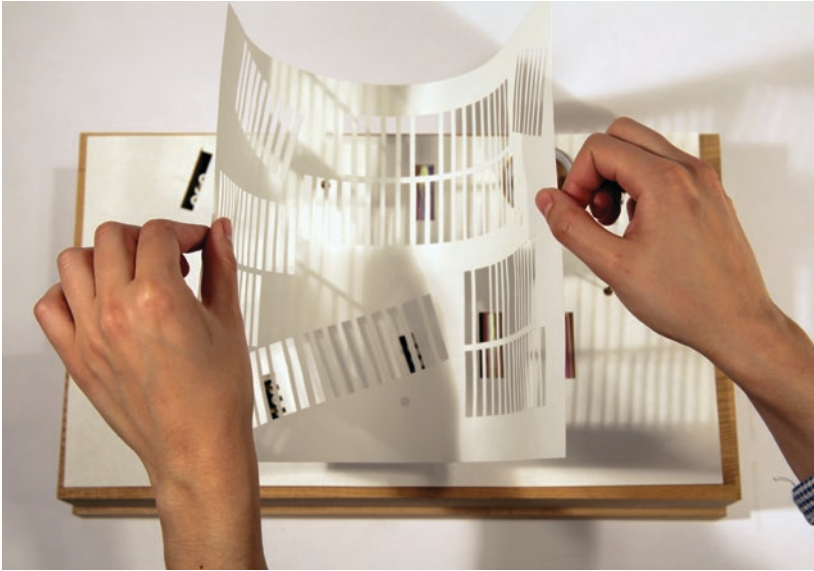
33



34

**33**  
Encircling walkways, which also act as a wildlife hides, are suspended high above the river level and progress between the pans, offering views of bird activity in the captured river territories.

**34**  
The model is constructed in three layers. Here the paper layer is removed revealing the relationship between the mechanisms and the architectural model.

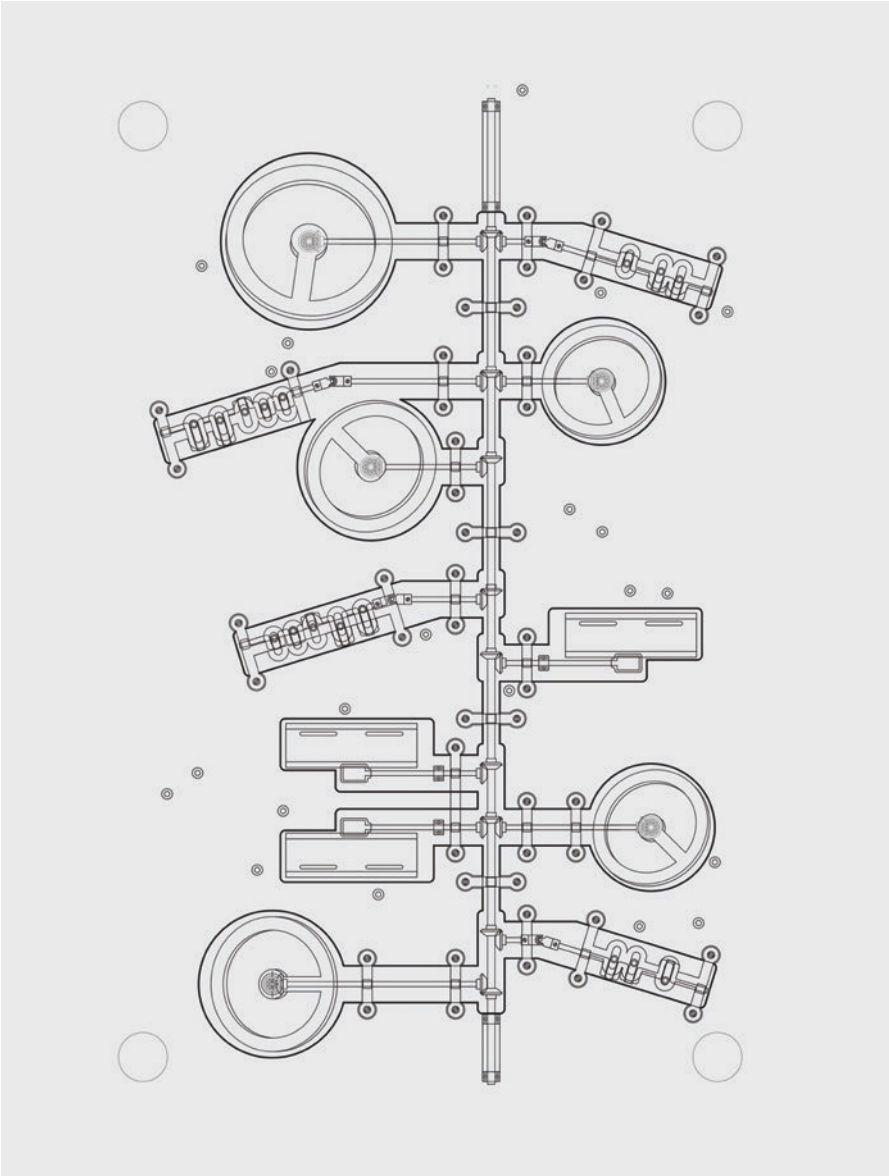


35a



35b

**35**  
**Model photographs**  
**showing undulating**  
**paper layers which**  
**represent the river**  
**flow**



36

**36**  
Instant Island model  
base layer technical  
drawing showing  
mechanical elements,  
such as angled

rotating discs and  
rollers which can be  
seen flashing through  
paper layers to give  
the impression of  
fluid motion.



37



38

**37**  
**Surfers. Tidal Surge**  
**Severn Estuary**  
Image in the public domain  
via Creative Commons

**38**  
**Showing the**  
**relationship between**  
**river level and the**  
**cliff-top cradles**





39

## Dissemination

### Exhibitions

- Group: *London Eight* at Southern California Institute of Architecture (SCI-Arc), Los Angeles, 21 Mar – 5 May 2010.
- Group: *Summer Exhibition* at the Royal Academy of Arts, London, UK, 14 Jun – 22 Aug 2010.
- Group: *Landscape Futures: Instruments, Devices and Architectural Inventions*, Centre for Art and Environment, Nevada Museum of Art, Reno, USA, 13 Aug 2011 – 19 Feb 2012.
- Solo: *Envirographic Architecture* at the University of Manitoba, Canada, 23 Jan – 2 Mar 2012.

### Invited talks

- 'Neo-Nature', part of the 'How to Architecture?' lecture series at the Bauhaus, Weimar, May 2010.
- 'Envirographic architecture', part of the RIBA Climate Change Lecture Series, at UCL, Sep 2010.
- 'Landscape Futures Super Workshop' at the Center for Land Use Interpretation (CLUI), Los Angeles, Oct 2010.
- 'Envirographic architecture' at the University of Cambridge, Nov 2011.
- Flows, Systems, Atoms: Architecture in the Expanded Field*, symposium at UC Berkeley, California, Feb 2012.

### Journal articles

- 'Lanzarote, a changing climate, the "envirogrammic" response'. *Forward: The Architecture and Design Journal of the American Institute of Architecture's National Associates Committee* 111 [special issue on Landscape] (Spring 2011): 70–79.
- 'Neo-nature'. *Horizonte: Journal of Architectural Discourse 2* [special issue on How to Architecture?] (Fall 2010): 81–88.

### Book chapters

- 'The "envirogrammic" response'. *Performative Materials in Architecture and Design*. Ed. Rashida Ng and Sneha Patel. Bristol: Intellect Books, 2013: 210–211.
- 'Superscript: an interview with Mark Smout and Laura Allen'. *Landscape Futures: Instruments, Devices and Architectural Inventions*. Ed. Geoff Manaugh. Barcelona: Actar, 2013: 123–138.

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- Helen Thomas, 'Lanzarote, Wonderground'. *OASE Journal for Architecture* 64 [special issue on *Landscape and Mass Tourism*] (Summer 2004): 90–109.

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## **Related publications by the researcher(s)**

### **Journal articles**

pp. 50–60

Mark Smout and Laura Allen, 'Lanzarote, a changing climate, the "envirogrammic" response'. *Forward: The Architecture and Design Journal of the American Institute of Architecture's National Associates Committee* 111 [special issue on *Landscape*] (Spring 2011): 70–79.

pp. 61–70

Mark Smout with Ortrun Barghols and Michael Kraus, 'Neo-nature'. *Horizonte: Journal of Architectural Discourse 2* [special issue on *How to Architecture?*] (Fall 2010): 81–88. <http://issuu.com/horizonte-architekturdiskurs/docs/horizonte-no.2/80>

### **Book chapters**

pp. 71–73

Mark Smout and Laura Allen, 'The "envirogrammic" response'. *Performative Materials in Architecture and Design*. Ed. Rashida Ng and Sneha Patel. Bristol: Intellect Books, 2013: 210–211.

pp. 74–90

Mark Smout and Laura Allen with Geoff Manaugh, 'Superscape: an interview with Mark Smout and Laura Allen'. *Landscape Futures: Instruments, Devices and Architectural Inventions*. Ed. Geoff Manaugh. Barcelona: Actar, 2013: 123–138.

## **Related writings by others**

### **Book chapter**

pp. 92–131

Geoff Manaugh, 'Landscape futures: curator's essay'. *Landscape Futures: Instruments, Devices and Architectural Inventions*. Ed. Geoff Manaugh. Barcelona: Actar. 2013: 15–53.

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pp. 133–134

Vicky Richardson, 'Smout Allen have been exploring the relationships between man and nature, technology and environment, through teaching and research'. *Blueprint Magazine* 289 (Mar 2010): 19.

pp. 135–137

Michael Webb, 'London Eight, curated by Peter Cook, Los Angeles, USA'. *Architectural Review* 1359 (17 May 2010): 90–91. [www.architectural-review.com/reviews/london-eight-curated-by-peter-cook-los-angeles-usa/5217828.article](http://www.architectural-review.com/reviews/london-eight-curated-by-peter-cook-los-angeles-usa/5217828.article)

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A. Moret, 'London Eight: Sir Peter Cook liberates the world from the conventions of digital architecture'. *Flaunt Magazine* 109 (Apr 2010): 58.

### **Web**

pp. 140–143

Alex Groszek, 'RIBA Climate Change roadshow concludes at The Bartlett'. *Footprint: Hattie Hartman's Sustainability Blog* (24 Nov 2010): <http://blog.emap.com/footprint/2010/11/24/riba-climate-change-roadshow-concludes-at-the-bartlett>

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by mam, Grymsdyke Farm  
and REX|LAB

***Banyoles Old Town  
Refurbishment***  
by Miàs Architects

***Torre Baró Apartment  
Building***  
by Miàs Architects

***Alzheimer's Respite Centre***  
by Níall McLaughlin  
Architects

***Bishop Edward King Chapel***  
by Níall McLaughlin  
Architects

***Block N15 Façade,  
Olympic Village***  
by Níall McLaughlin  
Architects

***Regeneration of  
Birzeit Historic Centre***  
by Palestine Regeneration  
Team

***PerFORM***  
by Protoarchitecture Lab

***55/02***  
by sixteen\* (makers)

***Envirographic and  
Techno Natures***  
by Smout Allen

***Hydrological Infrastructures***  
by Smout Allen

***Lunar Wood***  
by Smout Allen

***Universal Tea Machine***  
by Smout Allen

***British Exploratory  
Land Archive***  
by Smout Allen  
and Geoff Manaugh

***101 Spinning Wardrobe***  
by Storp Weber Architects

***Blind Spot House***  
by Storp Weber Architects

***Green Belt Movement  
Teaching and Learning  
Pavilion***  
by Patrick Weber

***Modulating Light and Views***  
by Patrick Weber