

SONUS MARIS

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Abstract

Sonus Maris is a collaborative creative-research project at the Water Research Laboratory, Sydney Australia (University of New South Wales) which is developing a series of artworks that attempt to manifest the underlying dynamics and complex interaction of natural climate and oceanic systems. Employing visual and telemetric data from satellites as well as on the ground observations and ariel surveying the research team aim to generate sophisticated sonification and visualisation that offer a palpable and visceral experience of the long-term flows and patterns as well as of the singularities that make up the world around us.

Keywords

Art and Science, Environmental-art, Bio-art, Sonification, Visualisation, Sound-art, Sound-sculpture, Earth-observation, Climate-systems, Hydrology.

Introduction

Whilst the focus of this paper is upon the current creative-research project *Sonus Maris*, undertaken with the Water Research Laboratory of the University of New South Wales (Australia) it is placed within the context of a series of prior art and science projects which have endeavoured to reveal aspects of the environment and biosphere that are normally unavailable to our senses.

Works such as *Under the Icecap*, a long-term collaboration with the Institute for Marine and Antarctic Studies (University of Tasmania) that sonify and visualise bio-logging data collected from the deep under-ices dives of Southern Elephant Seals in Antarctica. *VoxAura* and *Take a Deep Breath; Breathless* reveal the subtle chemical variations in water and air quality respectively. And the ongoing *Oratorio for a Million Souls* project generates both real-time mixes and musical scores, based upon data-bee-hives installed in special bee listening architectures constructed in German and Dutch botanical gardens. These projects are the conceptual and developmental pathways for the current works.

*Sonus-Maris*¹ started life as a short artist in residence with the Water Research Laboratory in which the artist created a prototype sonic sculpture that made palpable the interactions of wave and tide action upon the deposition and erosion of sand along the axis of a famous Sydney surf beach called Narrabeen. The work took the

form of four giant Chaldini Plates driven by powerful audio transducers that delivered musical scores derived from data. Happily, the collaboration proved successful and the relationship has now flourished into a long-term creative art and science research project.

Sonus Maris, Version No.1 a context.

The Brain is wider than the Sky
For put them side by side

The one the other will contain
With ease and You, beside

The Brain is deeper than the sea
For hold them Blue to Blue
The one the other will absorb
As Sponges, Buckets do

The Brain is just the weight of God
For, Heft them, Pound for Pound
And they will differ, if they do
As Syllable from Sound.

Emily Dickinson, The Brain is wider than the Sky (1862)



Figure 1. *Sonus Maris* 2019, prototype installation (© Nigel Helyer).

¹. <http://www.sonicobjects.com/index.php/2019/12/16/sonus-maris/>

We are neurologically predisposed to seek patterns in our surroundings: in fact, pattern recognition is our core cognitive ability, vital to our evolution and survival as a species, as it affords the capacity for prediction.

In life as in art, we take delight in the symmetries, growth patterns and morphologies of the natural world as through them we recognise our formation. However, there is a constant flux between, on one hand, the regularity, or predictability of a pattern and on the other, the instability or turbulence that might threaten to render it indecipherable - to walk this tightrope between order and chaos is one of the central techniques of art, to distil clarity from chaos is the purpose of science.

In 1917 the Russian Formalist writer Viktor Shklovsky made a distinction between poetry and prose, coining the term *Ostranerie* (or Defamiliarisation) a device for making strange, to render a common thing in an unfamiliar manner or context to create a fresh perception of it. This trope of making strange with language has recurred throughout the twentieth century, surfacing in Freud's notion of the Unheimliche (the uncanny), Berthold Brecht's *Verfremdungseffekt* (the estrangement effect) and Jaques Derrida's *Différance* (which hovers somewhere between difference and deferment).

The probabilistic learning that pattern recognition develops is extremely useful in the prosaic world—it is the way we navigate our daily lives. However, in creative practice, we always require a twist to a narrative, a dissonant metaphor in a joke, or an unpredictable note to conclude a melodic series. This is the sweet spot, the point at which our expectations of regularity in a pattern are disrupted—but not too much, just enough to throw the brain into mild confusion. It is the fissure, the reveal, the punchline that reflects on the narrative arc and plays with our assumptions.

Science is based upon empirical evidence, it observes and carefully quantifies the complex phenomena that surround us in an attempt to make sense of chaos. At the small end of the scale, each wave that crashes onto the beach at Narrabeen creates a turbulent swirl of sediment, multiplied thousands of times in each storm. The scientists and engineers of the Water Research Laboratory understand these individual events as nonlinear interactions which are difficult, if not impossible to interpret or predict. However, they have been monitoring the shifting shoreline at Narrabeen for over 43 years and from this long-term view, it is possible to identify an accumulative effect in which the sand volume rotates between the northern and southern end of the beach in cycles that range between two to seven years. When considered in conjunction with wave and storm data an overarching mechanism driven by climate emerges - it is such a point of view that operates along the axis of the particular to the general that allows us to see the 'wood from the trees.'

A step back - How to make palpable the invisible?

Precursor 1. - *Under the Icecap*.

Science is constrained by Objectivity and Impartiality and perhaps Art is constrained by Subjectivity.

Our Bio-Sonic journey begins by heading toward the South Pole and the Sub-Antarctic Islands. *Under the Icecap* is a long-term Art and Science collaboration² that links scientific bio-logging data and GIS techniques with interactive acoustic cartography to develop a series of Audio-Portraits that extend the conceptual and intuitive grasp of extremely abstract bio-logging data.

The by-line for the Institute of Marine and Antarctic Studies is "Turning Nature into Knowledge." The *Under the IceCap* project supplies a second line "Turning Knowledge into Culture" encapsulating a powerful Art and Science synthesis and simultaneously raising the expectation but also the risk of the endeavour. The primary aim of the project is to produce creative works which are compelling and affective, but which can simultaneously be works of scientific utility; that hopefully tap into both sides of the brain! The key focus is to illuminate the relationship of the environmental knowledge generated from Antarctic bio-logging data with the Anthropogenic changes in the biosphere.

The collaborators realised that the extensive and extremely complex datasets collected by southern elephant seals (*Mirounga leonina*) represent a considerable interpretive challenge and provided the opportunity for a hybrid art and science exploration of new methods and forms for manifesting the data and to develop novel forms of public awareness and debate about the oceanographic and climatic data that the seals collect. Our aim is focused on developing techniques for visualising and sonifying the complex bio-logging data collected by southern elephant seals on their deep dives under the Antarctic Ice shelves and their long southern ocean transits.

We explore new ways to make these data-sets palpable, manifesting them as a series of experimental music concerts and visual and sonified installations with the express intention of illuminating the fundamental connection between human activities and planetary dynamics. The intention that drives our methodology is that the artistic and scientific paradigms which intersect in *Under the Icecap* form the basis of a robust and productive trans-disciplinary collaboration. The word collaboration is widely and often incorrectly used in art & science projects, typically one discipline being subservient to the other. However, the emphasis within *Under the Icecap* is to design an open, consensual and collective creative research process, that balances and complements the knowledge bases, motivations and target audiences of the art and science disciplines involved. Within a scientific context, such bio-logging data is most frequently

² Artist Dr Nigel Helyer (Sonic Objects; Sonic Architecture) and Marine Scientist Dr Mary-Anne Lea (Institute for Marine and Antarctic Studies at the University of Tasmania).

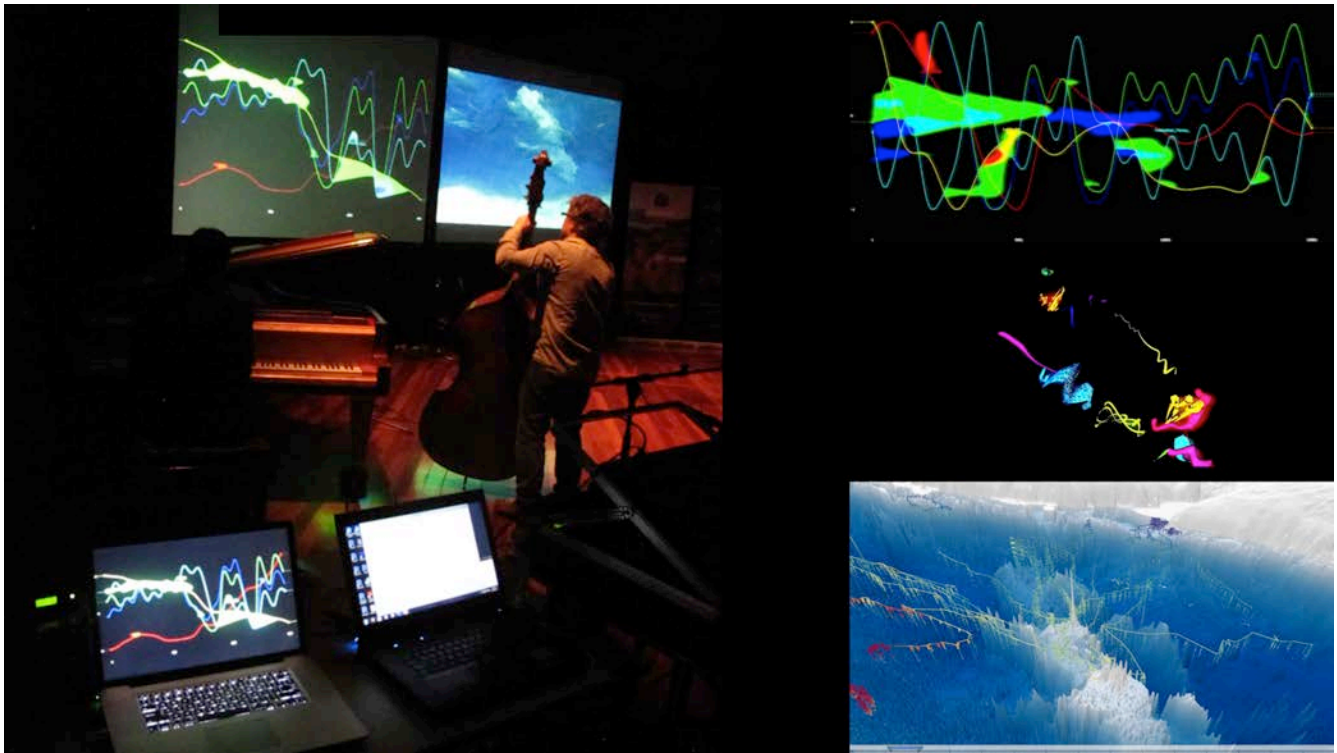


Figure 2. Bio-logging 2012, data rendered as animated maps and graphical scores in a live performance (© Nigel Helyer).

consigned to two-dimensional graphs each of which contains a limited range of variables, making a wholistic gestalt improbable, if not impossible to achieve. Searching for a more flexible approach we imagined a situation in which each of the many variables could be dynamically put into play, examined in real-time and generate on the fly responses - a kind of neural network.

Our solution, musicians! Our decision to interpret environmental data via an aural process is based upon a hunch that musicians have the best pattern-recognition wet-ware around and that our aural sensibility is in fact more finely tuned to detect minor variations in pattern and recognise subliminal differences, than our visual sense.

The large multi-factorial data sets are re-conceptualised in two ways. Firstly, using sophisticated cartographic software, we generate animated 3D maps of the data traces of individual elephant seals for large scale data-projection.

Using the same data we also generate various forms of graphical scores and again render these as dynamic projection works. These are then presented in parallel to a quartet of professional musicians in a live concert context where they are asked to respond individually and/or collectively to the material (there have been many structural variations on this method).

Naturally, the elephant (seal) in the room is the scientific allergy to a subjective, and non-repeatable response which some may consider renders the enterprise interesting but ultimately un-scientific. A somewhat cheeky rejoinder might be that statistical data is, in and of itself, an artefact and that its analysis is even more so. Does the bio-logging data in any manner resemble the

experience of a southern elephant seal feeding two Kilometres deep beneath an ice shelf at a pressure of one hundred and ninety-four atmospheres? As the British Prime Minister Disraeli once said -

“There are three kinds of lies;
lies, damned lies and statistics!”

Precursor 2. - *VoxAura; The River Sings.*

Our blood has the same salinity as the Ocean, a reminder of the origin of all life on the planet and a warning that we share our well-being with our vast and indifferent mother.

As terrestrial dwellers, it is easy to overlook the fact that we inhabit an essentially two-dimensional space

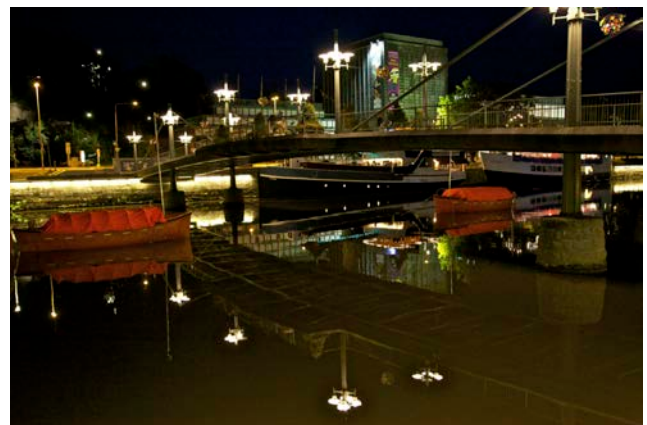


Figure 3. VoxAura, 2011, Turku, Finland. (© Nigel Helyer).

that has surface area but scant depth. By contrast, the marine world is three dimensional, its depths accounting for 99% of the Biosphere and its surface accounting for 70% of the planet's area. The ocean forms the principal inter-face for chemical exchange with the atmosphere, absorbing carbon dioxide and releasing oxygen – it is the pump that drives climate and regulates the air that we breathe.

Like other semi-enclosed bodies of water, the Baltic is brackish, its waters less saline than our tears. The River Aura flows through the port city of Turku, past the maze of low granite islands that form the Finnish archipelago and into the Baltic, carrying with it a mixture of chemical nutrients and effluents that simultaneously drive the annual algal bloom and degrade the complexity and fecundity of marine ecosystems. Put simply the Baltic has lost its clarity and its fish but has gained the reputation as the most polluted sea in the world.

*VoxAura; the River Sings*³ suggests that we pay attention to these complex issues that ultimately control our destiny by listening to the chemical composition of the Baltic.

The project consists of two vessels, moored on either side of Turku's Theatre Bridge, equipped with speakers which broadcast a soundscape. The first of these plays material from a large archive of sound recordings which evoke the maritime traditions and marine environment of the Baltic; whilst the second transforms this material, allowing us to 'listen' to water quality data that is constantly collected by two trans-Baltic ships and downloaded to the work. The project's computer system takes variables from this data, such as position, depth, temperature, salinity, turbidity and pH, using them as musical parameters to transform the source audio (which is playing simultaneously on the first vessel) producing an ethereal 'data music' as a metaphor for, or analogue of the chemical composition of the sea.

Precursor 3. - *Take a Deep Breath; Breathless.*

This work investigates the sonification of environmental data and how the resulting sound works can be installed into a public or architectural situation to create new forms of sonic space in which it is possible to experience, examine and reflect upon the complexities and consequences of our political and economic actions in an increasingly chaotic world.

Conceptually the work is similar to *VoxAura* in that it is structured in two parts, one originating in a social and cultural context, the other ecological and environmental. The work aims to integrate and interrogate the relationship between these spheres, and present them in an outdoor urban environment and/or public architectural space.



Figure 4. Take a Deep Breath-Breathless, street recording (© Cecelia Cmielewski).

*Take a Deep Breath; Breathless*⁴ concerns the atmosphere, the breath and the act of breathing. Breathing as meditation, as respiration, failing breath in respiratory diseases, the breathy sounds of our voices, of song and flute – ultimately the metaphor of breath as life itself.

During his sojourn in Delhi, the artist recorded a large audio library that embraced a wide range of ambient, vocal, environmental and musical sounds, in effect creating an AudioPortrait of the physical and social environment.

Atmospheric data was sourced directly from the City's environmental monitoring system providing a constant and somewhat alarming stream of digital information on the levels of pollutants in the Delhi atmosphere. Ironically, during the project New Delhi experienced the worst air pollution on record, driving home the point in a dramatic but unpleasant manner.

From a technical perspective the system consists of two components ~ firstly a large audio library that is capable of being updated via wifi – the second element is a correspondingly large library of environmental data sets which can be accessed either in real-time (online) or updated via wifi regularly. The system computer selects a sound file and data file at random and convolves them to render two stereo audio streams to the speaker array which was installed in the gallery space of the Portuguese Embassy's Cultural Centre.

As in *VoxAura*, one stereo pair of speakers plays the unadulterated audio file whilst the other plays the harmonic data-music that simultaneously renders some of the data structure, but which also has a sonic imprint of the audio original.

³ Vox Aura, commissioned by Turku, European Capital of Culture 2011. <https://www.sonicobjects.com/index.php/2011/08/01/voxaura>

⁴ *Take a Deep Breath; Breathless* was commissioned by the Sound Reasons, Sonic Cities Festival 2012 and took place in Delhi, India. https://www.sonicobjects.com/index.php/2014/06/29/breathless_take_a_deep_breath

Precursor 4. - *Oratorio for a Million Souls.*

*Oratorio for a Million Souls*⁵ is a public art project that spans three physical locations and was designed to contribute directly to the debate around issues of biodiversity and the population collapse of bird and insect species in Europe. The decision to work with bees developed from a long-standing interest in the cultural metaphors that have historically been associated with colonial insects (especially honeybees).



Figure 5. *Oratorio for a Million Souls* (2018 ~ 2022) B-Rhapsodie concert in the de Kriedhof Botanical Gardens. (© Nigel Helyer).

The organisation of the hive with its epigenetic formation of social ranks and the strict division of labour have long been used as a template for human social and political regimes. Characterised as obedient, efficient and with a selfless devotion to the common cause, bee society has been a paradigm vaunted by autocracies and monarchies for centuries; only recently has research demonstrated the remarkable level of consensual decision making that rewrites the old hierarchical stereotypes. The second strand of interest is focused upon the complex abilities of communication, navigation and collective problem solving that are performed not by each individual, but as a network – the *hive-mind* an entirely different paradigm a ‘rule from above’ model. The level of parallel processing and complex communications evolved by bees over 100 million years render the hive a true *Super-Organism*.

It was in this context that the *Oratorio for a Million Souls*⁶ developed three bee-listening architectures sited in European botanical gardens, each structure equipped with two sensor hives. As the work is extensively described in the proceedings of ISEA2019⁷ here the focus is on the creation of musical scores, which function externally to the public artworks per se. The score was based upon two streams of real-time audio from the sensor

hives; one from miniature DPA microphones embedded in the entry and exit ports of each hive and a second stream from custom-built contact microphones placed deep within the hive itself. The audio content was complemented by data extracted from a series of hive exit and entry sensors that provided a picture of the diurnal activities of bee colonies, which generally correspond to external temperature and light levels. The audio recordings were employed to establish a tonal palette that was subsequently quantized into an even-tempered scale. The bee movement data was parsed into a rhythmic and temporal framework, giving the score its overarching structure. In contrast to the more stochastic processes of the previous works, once the ground rules were established, the musical form took on a life of its own, bound by the parameters derived from the original hive audio and data.

The resulting scores were, from the perspective of the three large brass and wind ensembles, quite unconventional and challenging to play. The performative challenge was amplified by the technical and logistical difficulties in synchronising the three-part score via an audio-visual satellite link-up that connected the botanical garden in Buitenpost (Netherlands) with gardens in Emden and Oldenburg (Germany).

The outcome of the debut performance which launched the overall project, was a success, despite the inclement weather which drizzled into the mouths of Tubas and Bass Saxophones – a tribute to the hive-mind of the musicians, conductors; sound engineers and cultural producers – it seems that we may have learnt something from the bees!

Sonus Maris, Version No.2 - Work in Progress.

The current *Sonus Maris* collaboration, which is in its developmental stage, initially places its attention upon the extraordinary coastal environment in which the art and science team live. The Eastern Seaboard of Australia is the greenest and most fertile part of the continent (and naturally the most populated). Measured South to North the coastline is approximately 4000 kilometres and supports a wide variety of coastal waterways.

These include tidal creeks (35%), wave-dominated estuaries (17%), tide-dominated estuaries (11%), wave-dominated deltas (10%), tide-dominated deltas (9%) and strand plains (5%), with the remaining 13% comprising drowned river valleys, bays, coastal lakes, lagoons and creeks. Many of these coastal freshwater resources are only intermittently open to the sea and are termed *Intermittently closed or open lakes and lagoons* (ICOLLs) and these are our current focus of interest. Australia is home to 305 (21%) of 1477 globally mapped ICOLL systems.

5. Commissioned by the European Capital of Culture, Leeuwarden, Netherlands 2018.

6. <https://www.sonicobjects.com/index.php/2019/04/14/the-oratorio-for-a-million-souls>

7. *Heavy Metal and the Oratorio for a Million Souls*, Dr Nigel Helyer & Dr Jon Drummond, Proceedings of the 25th Symposium on Electronic Art (2019) Pg 18 ~ 23.



Figure 6. A coastal river system with a narrow opening to the sea, New South Wales east coast ((© WRL).

The principal research collaborator at the lab, Valentin Heimhuber is an environmental researcher & engineer working on the integrated management of river systems, wetlands, and estuaries in the context of climate change and the pressures of population growth. His work focuses on the use of large satellite datasets and machine learning to develop new tools for the improved management of water resources and water-dependent ecosystems. Valentin is particularly interested in using data to find the right balance between human and environmental water requirements in catchments, rivers and coastlines.

Valentin has developed an algorithm *InletTracker*⁸ that draws upon more than three decades of public-domain satellite imagery (Landsat 5, 7 and 8 and Sentinel-2). His new analytical tool can reconstruct the dynamics of ICOLLs by retro-analysing the relatively low-resolution satellite images to identify the flow patterns and frequencies of these water bodies, thus providing a historical perspective that demonstrates the cyclical nature of interactions between fresh-water and salt-water bodies. *InletTracker* reveals when and how they open and close to the ocean and this data can then be correlated with the associated climatic and oceanic data to illustrate a complex web of environmental interactions, which may hopefully indicate future behaviours under the influence of a changing climate.

The ingenuity of *InletTracker* (a Google Earth Engine enabled python tool) is that it functions to recreate observational data of environmental events that were not previously intentionally observed or recorded. The system uses a novel least-cost pathfinding approach to trace inlet channels along and across the barrier/berm, and then analyses the resulting transects to infer the minimum channel width and whether an inlet is open or closed. The tool is simple to use and provides data on the location and shape of entrance channels, their width at the throat and their status (open or closed to the ocean).

The principal drivers of such interactions are; terrestrial rainfall; fluvial action; wave and tidal action;



Figure 7. Preparation of the original Landsat capsule (© public domain).

atmospheric pressure and associated storm events. All of which combine to set in motion a constant but irregular cycle of opening and closing water bodies, which have implications for coastal integrity and human habitation and coastal land use.

As in all of the pre-cursor projects, the dominant concern is how to manifest such complex data in a way that makes it palpable, visceral and emotionally engaging. How can these complex webs of information become something that illuminates the fundamental connection between our human activities and planetary dynamics as it spins out of control? My initial and immediate response was to imagine the complex web of climatic and oceanographic interactions as a form of musical instrument—perhaps an organ, voicing and modulating as the environmental unconditions fluctuate.

How to begin a conversation?

Following this musical metaphor, we have selected the flows of six ICOLL water bodies to create an organic musical score; an instrument conceived on a geophysical scale. The soundscape (or score) will be accompanied by rich data visualisations and inter-mixed with actual

⁸. The *InletTracker* <<https://github.com/VHeimhuber/InletTracker>>

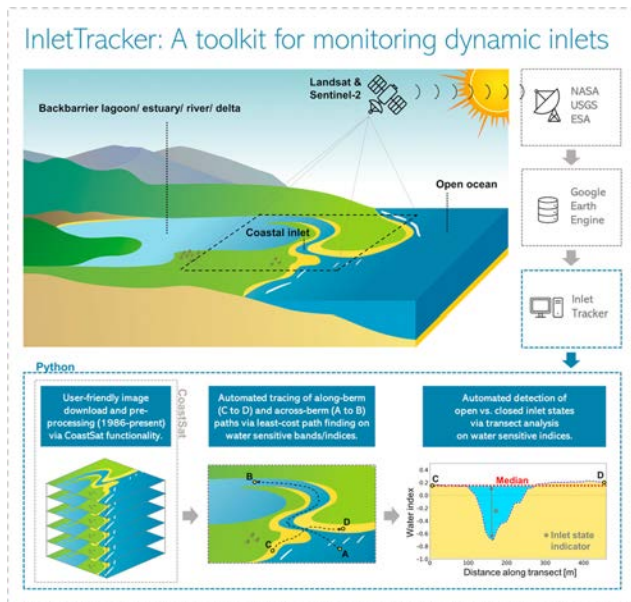


Figure 8. An InletTracker schematic.
(© Valentino Heimhuber).

environmental recordings using a variety of visual technologies (video, LIDAR, particle modelling etc) as well as acoustic ecology microphony techniques.

The intention is to establish an indexical relationship between the data and the musical structure, similar to *Under the IceCap*, where the data itself ‘authored’ the mappings and graphical scores, with the oceanic data providing strict relationships between, for example, depth pressure, temperature, salinity and turbidity, none of which were influenced by subjective interpretation.

Likewise, we envisage that the new *Sonus Maris* project will bring together the environmental flows of coastal lagoons and estuaries as they debouch into the Tasman Sea in a manner that will directly translate the observed data into a soundscape, but one that has not passed through a conspicuous layer of (subjective) interpretation (beyond the process of establishing the parameters for assigning sounds and their properties to the various data sets). Here the sonic output will be structured directly by the InletTracker data, itself, generated through an analysis of the pixels present in Landsat images.

The project is scheduled to debut in December 2022 in Sydney, Australia at the 37th International Conference on Coastal Engineering as a large-format data projection with options for both digital sound and a version with a live musical performance of the data structures. The project will also generate a touring exhibition and a dedicated website.

To conclude.

Concern for the environment has become a central political and artistic issue in the contemporary world. Environmental science and climate change science now perform crucial roles in analysing, and forecasting, the (increasingly precarious) state of the global environment. Siân Ede, in his book “Art and Science,” has proposed that ‘the fragile environment’ might well become ‘the most crucial matter for the future concerns of both artists and scientists.’⁹

However, the broader public (and political) realisation that art and science can form powerful and symbiotic relationships with benefits that extend into all aspects of social, economic and cultural life has been a long time coming.

*‘L’art c’est al science faite chair’*¹⁰

‘Art is science embodied’ these words by the French poet Jean Cocteau written in 1918 neatly encapsulate a perspective in which art and science are imagined as two expressions—as two voices of the same spirit of enquiry, but perhaps delivered in a different register. Cocteau’s short phrase employs the French word ‘chair,’ in English quite literally ‘flesh,’ emphasising that art brings science into the visceral world as a palpable experience, and by so doing it can become something that we can relate to directly—a narrative behind the data! It is this embodiment of curiosity, of knowledge, and sheer wonder that the melding of art and science is all about.

Artist Biography.

Dr Nigel Helyer (aka DrSonique) is a contemporary sculptor and sound artist whose work links Art and Science to embrace the environment; identity and cultural history. He has an international reputation for his large scale sound sculptures, environmental artworks and interactive bio-art projects that prompt the community to engage with their cultural histories, identity and sense of place; inviting us to examine the abstract conditions of our world and our complex relationships to it. Nigel is the director of SonicObjects; Sonic Architecture <<http://www.sonicobjects.com>> an Honorary Professor in the school of Media, Music, Communications and Cultural Studies at Macquarie University, Australia <<https://www.mq.edu.au/faculty-of-arts/departments-and-schools/department-of-media-communications-creative-arts-language-and-literature>> and is currently the Artist in Residence at the Water Research Laboratory, The University of New South Wales, Australia <<https://www.wrl.unsw.edu.au/>>

⁹ Siân Ede, *Art and Science*, p. 12.

¹⁰ Jean Cocteau, *Le Coq et L’Arlequin*, 1918, p. 11.

