On breathing and geography – sonifying the Severn as shared generative art practice

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The Severn Estuary in Southwest England (fig. 1) deserves great attention: with an enormous tidal range and three million people living around its shores, it is a unique site of interlinked and clashing rhythms. Moreover, the passage over or under the estuary, industry and tourism affects a much wider, and not necessarily local, population group. This is the target audience for Sonic Severn, [1] a small but growing online collection of soundscapes, sonifications and compositions about the Severn Estuary, curated by Tidal Severn.

Using the example of a more recent data-driven sonification prototype that explores the Severn estuary rhythms, this paper discusses possible frameworks for larger, multi-dimensional sonifications. It explores the necessary compromises between quantifying and qualifying data that can influence listeners' interpretation of sounds, and discusses different kinds of 'accuracies' that may be applied in the creation of sonic representations. These accuracies are often connected with listeners' perceptions of how they are connected with this landscape. It is argued that skillful use of sound compositional techniques, data mapping and participatory practices can deepen and intensify listeners' experiences of generative processes.

The sea's ebbs and flows, storms, swirls and stagnant waters have inspired many well-known compositions, such as Vivaldi's La Tempesta di Mare, Debussy's La Mer, or Vaughan Williams' Sea Symphony. Some of the rhythms of the sea can be especially well grasped in tidal landscapes such as the Severn estuary. But in addition to rhythmic changes, more intrinsic links between tidal landscapes and sound practices can be made. For example, plots of tidal ranges and plots generated by sound oscillators both exhibit typical sine wave structures. Coastal gauges calculate the tide height by mathematically eliminating wave heights, while in sound synthesis gauges limit the frequency range of signals. Tidal patterns are predicted via Fourier analysis – a method that examines fundamentals and their harmonics – while in sound practices Fourier analysis can be used for the generation of overtone-rich notes. Thus many of the methods used for the analysis of tidal processes are also applied in sound synthesis.

For a tidal sonification, exploring these commonalities may seem like a useful starting point, and yet such an approach overlooks the role of human experience. A landscape like the Severn estuary is not only read logically. Once immersed in it, sensations force themselves upon us: its unforgiving wind blasts the skin and makes the eyes water, its rain sticks sand grains to the skin; we smell and taste it. Before we know it, these sensations are shaped by our internal blueprints – memories, habits, cultural norms – and so we might start to think that the wind intentionally plays with our bodies, or that the estuary teases us with mudflats and quicksand pools. Interpreting what is around us is such a strong mechanism. It informs our habitual thinking patterns and shapes our expectations. When it fails, we tend to feel let down by the situation we encounter and less so by our expectations of it. Heading for a day out at the Severn beach for instance, we might be disappointed with the vacant scrubland we find but still not question what we hoped to see.

Indeed, habitual thinking patterns are hard to break. They can easily undermine the process of sound mapping itself. If we were to map the Severn estuary sediment for example, we would encounter the following problem: although the Severn estuary has one of the best-researched sedimentary regimes in the world, it is still difficult to pinpoint the sediment location. This is because the 30 million tons of fine silt that are suspended in the estuary's waters during a typical spring tide, are not equally distributed. There are areas of denser and less dense suspension, and some areas remain stationary (pools) while others move with the tides (slugs). [2] Moreover, the amount of moved material depends on the severity of each tide, which in turn influences the re-distribution of the landmass (erosion and deposition). Thus research – as well as first-hand observation – tells us that in this intertidal environment, a simple distinction between water and land is quite misplaced: land and water here permeate each other in very unpredictable ways. And yet, when thinking about the estuary, how easy it is to picture a map in our minds where a simple coastline separates land from water.

To arrive at a new mapping strategy for the estuary, one might therefore consider an artefact that literally redraws itself with each tide. Since the coastal shape would no longer be recognizable, the artefact could orientate its users via site-specific sound beacons instead, for example the sounds of the seagull colonies on Flatholm island. Beacons like this contain information not only about the physicality and materiality of a location, but also on the condition of the sounding objects embedded in them. Thus the use of real-time sound beacons can help to experience a landscape afresh. [3]

To move listeners between locations, this artefact would have an interactive interface. Listeners would only hear sounds within a certain range of their position, like one does on sound recording trips. This can encourage discovery via comparative listening, for example the discovery of different wave sounds caused by different bathometries: at Clevedon seafront for example one might hear small waves rushing onto a pebble-covered bay, while at Burnham-on-Sea the wide-open sandy flats only produce occasional water ripples.

To further an understanding of the interdependence of the environmental processes in the estuary, this artefact also needs to become scalable. ‘Zooming out’ would enable synthetic listening (listening to the estuary as a whole), which in turn allows to make new connections between different sound events, for instance between the sonified lunar zenith and its following high tide, or between wind conditions and tide height.

While this new mapping strategy provides an outline for a developmental direction, Tidal Severn’s current sonification prototype is still at a much earlier stage. At the moment it taps into three kinds of data: the level of tide over the mean sea level, weather data (wind speed, direction, atmospheric pressure) which influences the tide, and the solar-lunar constellation which also affects the tide. Since tidal data is multi-dimensional and human memory limited – our short-term memory can only hold about seven items of information at the same time [4] – data interpretation becomes increasingly difficult the more data streams are used; hence the limitation of the number of data streams.

These data streams were then mapped to groups of sounds. The key technique used hereby was parameter mapping, [5] which means that changes in numeric data values affect the attributes of sounds (such as onset, frequency, duration or amplitude). In parameter mapping, the relationship between sound and data can established as directly proportional (rising water level = rising pitch), scaled (rising water level = logarithmic rise of pitch) or otherwise mathematically defined. Thresholds, where the data indicates significant changes, can be acoustically marked, for example as flood warning sounds.

A known disadvantage of parameter mapping is that listeners need to understand the mapping strategy before they can understand the meaning of the changes in the sounds. [6] However, it was found that listeners needed less training if sound timbres were selected perceptually and applied consistently. Thus in the sonification prototype, sound metaphors (swelling and ebbing of sounds = swelling and ebbing of a water body) and self-labelling sounds (wind-like sounds = wind data) were used to allow for an intuitive attribution of sound to source. Moreover, the three sounds were acoustically grouped, each having distinct timbres (sound colours). The attributes of each group (pitch, duration etc) remained data-driven, but their timbres constant. This strategy seemed to aid comparative listening, as listeners noticed site-specific characteristics in the data more easily than when different mapping strategies were used.

Another finding was the influence of time compression on listeners' perception of the sounds. It is said we are more likely to pay attention to short sound events with a distinct change in dynamics (waves crashing into a seawall) but to ignore long drawn-out processes that show little change in rhythm or dynamics (a receding tide revealing mud flats). To explore this notion, the sonification prototype was tested with a number of time compression ratios. The data would no longer be sonified in real-time, but instead one tidal cycle's worth of data compressed into minutes. For many listeners the interrelations between the three sounds became more apparent when the data was scaled in such a way. Then listeners also seemed to become more sensitive to structured motion (rhythm) and were able to distinguish regular from unusual patterns more easily.

Indeed, if the Severn estuary rhythms were to be described by time classifications in music, the tide would fall into a 'macro timescale' of musical architecture or form, which according to Roads is measured in minutes, hours or days. [7] The tide in the estuary is duo-diurnal, which means that only after 12 hours or so it reaches the end of one basic unit of time (or beat). The relative positions of earth, moon and sun on the other hand only repeat themselves every 19 years or so. This kind of rhythm corresponds to the 'supra timescale,' covering months, years, decades and centuries. [7] Since neither timescale connects to an everyday experience of duration, only an experienced observer would notice an unusual change, for instance in the monthly spring-neap cycle or the annual tidal cycle.

Weather patterns, on the other hand, fall within our everyday experience of duration, but since these are characterized by arrhythmic repetition – strong gusts of wind, or rainy days with sunny intervals are quite common in the estuary – it is not always obvious how the seemingly chaotic weather patterns relate to the seemingly regular tidal patterns. Thus a problem that affects real-time tidal sonifications is that since they do not coincide with habitual notions of duration, the cyclical nature of their rhythms may remain elusive to many listeners.

On a deeper level, this leads to the question as to when artefacts that translate data into sound can actually be said to be successful. To answer this, it is useful to turn to earlier days of sonification practice, when sonifications were defined as "the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation." [8] According to this, the aim of communication or interpretation should guide the sound mapping process. This has not lost any of is its validity, however, more recently it has been demanded that, at least within a scientific context, sonifications must also reflect objective relations in the input data, use systematic means to translate the data into sound, and should be set up in such a way that they are repeatable and reproducible. [9] What is often criticized nowadays about art-related sonification artefacts like the Severn prototype is that their algorithms are not made transparent, and so it remains unclear as to whether the sonification was carried out objectively and systematically.

In principle, this is a valid concern, yet the kind of objectivity called for is often hard to ascertain with the kind and quality of field data available. The Severn estuary is itself a part of a larger ecosystem, and so it is hard to define the boundaries of any of its data streams; for example the local weather conditions measured in the region are often the results of larger changes somewhere else in the system. It is important to understand this global link, but without limiting the data in some ways, characteristic local weather patterns may not be observable at all. A further complication is that most publically available scientific data is not updated in real-time. Tidal data for instance relies on – not completely accurate – predictions; and a weather station in Alveston that updates itself every 2.5 seconds is the nearest real-time data source in the area. Most other available data is time-delayed and/or somewhat coarse, only exposing its characteristic patterns with a degree of inaccuracy.

Objectivity is also hard to ascertain when the act of sonifying data already involves perception; at first in form of the researcher who maps data to sound, and then in form of listeners who re-interpret what they hear. Moreover, many data sources from the estuary represent vast numbers of very small elements. As humans we do not have an intuitive grasp of very large or very small numbers, and so it remains a challenge to successfully sonify, for example, 30 million tons of silt suspended in water. Since a directly proportional mapping of data to sound might not be adequate here, a more interpretative mapping strategy might be applied to aid communication. However, this already influences listeners' perception in a particular way.

But since the role of perception is so hard to exclude, it might be useful to integrate it more explicitly into the methodology. To this end, Lefebvre's Rhythmanalysis [10] provides a useful frame of reference, as it intrinsically connects the researcher's thoughts and experiences with the geographical location where the rhythmanalysis takes place. With references to musical rhythms as well as tidal rhythms, Lefebvre's framework appears as particularly suitable for a sonification of the Severn estuary, yet its adoption is not entirely straightforward. For example, when Lefebvre introduces the notion of "lunar towns of the oceans," and "solar towns of the Mediterranean," [11] this may seem appropriate on some level; tidal rhythms are still engrained into the architecture of lunar cities and present in form of estuary-related professions. However, on another level, one might wonder about individual inhabitants' perceptions of the interplay of diurnal and lunar rhythms. Thus to allow for greater self-representation of those researched, a more participatory version of rhythmanalysis is required, one that can map the polyrhythmic exchanges that actually take place between estuary inhabitants and the landscape.

To this end, researchers like Biggs have pursued a deep mapping of a small number of estuary locations. [12] Deep mapping focuses on qualitative data, which is obtained through a collaborative process involving inhabitants and concerned parties. Although "in performance and archaeological circles in the UK, deep mapping refers primarily to site-based performances by Mike Pearson, Michael Shanks, Clifford McLucas, and the radical Welsh performance group *Brith Gof*," [13] deep mapping has been used much more widely. It can reveal radical perspectives, particularly when it abandons the traditional researcher-led perspective for collaborative methods and processes. A deep mapping that involves estuary residents would be able to map thoughts and issues in their complexity and, according to Biggs, challenge "distinctions between academic and artistic outcomes, between healing fictions and scholarly critique, between amateurs and professionals." [13]

For an artefact that successfully sonifies Severn estuary rhythms, it seems that participatory practices like deep mapping need to be used alongside established data communication methods. In this way, intuitive connections between observed tidal phenomena and their experience can more easily be made. Moreover, creating the possibility of moving between measuring and sensing, between different time and map scales involves listeners cognitively as well as emotionally. As Lefebvre remarked, this can open the door to new insights: "our scale determines our location, our place in the space-time of the universe: what we perceive of it and what serves as a point of departure for practice, as for theoretical knowledge. […] Another scale would determine another world. The same? Without doubt, but differently grasped." [14]

And according to Lefebvre, it should also be possible to connect with complex natural phenomena more deeply when we can relate them to our own bodily rhythms. Thus the following may serve as a concluding thought experiment: It takes the duration of about 12000 human in and outbreaths for the Severn estuary to complete one tidal cycle. Counting thousands of breaths in order to grasp the nature of the tide is however simply unbearable, as the difference between the two durational scales is too great. But when we mentally switch scales, an intuitive connection can quickly be made: by observing how, like the tide, each breath unfolds slightly differently each time; how it naturally accelerates, decelerates, pauses and turns direction.

Dr Michaela Palmer and Dr Owain Jones are Tidal Severn, an interdisciplinary research team that provides information, teaching materials and presentations in order to raise public awareness about the Severn Estuary, a large and important intertidal landscape in Southwest England.

Sonic Severn is open to composers, sound designers and sound artists who wish to work with some of the phenomena of the Severn Estuary, in order to share what is in living memory and to open listeners' minds to the fragile relationships between human experience and local landscape.

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