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Coastal Environment Alterations and Sensory Landscape

Abstract

Coastal environment, its natural world, and humans, are besides climate change effects subject to significant pressures by maritime-related, tourism, energy, aquaculture, and other sectors, all resulting in chemical pollution of all environmental components, noise pollution, and visual pollution. Humans attempt to adapt, mainly through devising and applying technological solutions. The senses incorporate the environment into the body and there is a mismatch between the way senses evolved and present surroundings, causing the disruption of visual acuity, smell, taste, and hearing. The disruptions to sensory landscape have thus altered the relationships between the organisms and the environment. The perceptual world or 'umwelt' differs for each organism. The impacts of environmental alterations to sensory landscape disrupt human sensory functioning, resulting in health impacts. Habitat disturbance in aquatic environments caused by acidification, contaminants, noise, optical degradation, elevated temperature, and electromagnetic fields can severely impact animal sensory biology. The paper focuses on sensory system responses of both humans and the wildlife to anthropogenically-induced and climate changes, reviews the issues resulting therefrom, and proposes solutions.

Keywords: coastal environment, sensory landscape, senses, climate change, pollution

1. Introduction

The senses constitute an organism's primary source of information about the environment, incorporate environment into the body, and create a perceptual landscape that shapes behaviour [1]. Human activities introduce novel stimuli ranging from anthropogenic noise and artificial lights to chemical agents. The result is an increasing number of sensory disruptions and their loss. On the other hand, there is an insufficient knowledge about ecological effects of sensory pollutants and the mechanisms contributing thereto, which limits our capacity to devise mitigation measures [2].

The paper presents an interaction between the senses and the environment, mentions some known sensory disruptions and their effect on human well-being and health. An analysis of current coastal sensescape is presented as well as the sensory notation tool which may aid in design, planning, environmental impact assessment, and audit.

2. Senses and the environment

The world of every organism is the sum of all the information being received and processed by that organism's nervous system. Thus perceptual world or *umwelt*, as coined by Jacob van Uexküll in 1909 differs for each organism although in considering sensory ecology of other animals, humans tend to focus on what they themselves know best, that being the sound (hearing), light (vision), chemicals (smell and taste), mainly in vertebrate organisms [3]. Furthermore, the shifts in behaviour are analysed mostly and not the responses of sensory systems that stimulate such behavioural changes [4]. On the top of that, sensory ecology of humans is insufficiently known [5].

Human environment in which we live, although considered to be a linear progression out of nature into built spaces, is very much different from the environment to which human senses were tuned [1]. Built environment brought about radical alterations of the sensescape. Here the term sensescape bears an analogy with ocular-centric landscape, whereby visualscape, smellscape, tastescape, soundscape, haptiscape refer respectively to visual, aural, gustatory, olfactory, and tactile sensory dimensions.

3. Sensory disruptions

Climate change, the destruction of habitats, and the presence of non-native species initiated significant processes with regard to natural ecosystems. However, few studies examine the impact of those threats on the senses and species' responses to environmental change. Environmental disruption often leads to biodiversity loss, although populations may express phenotypic responses to environmental change [4].

Air pollution for instance was found to degrade phytogenic hydrocarbon chemical signals produced by plant sources through an increase in the chemical reactions occurring in air parcels carrying scents away from source. In such a way the distances at which pollinators may detect floral scents has reduced to a great extent since pre-industrial times. All that contributes to reduced pollinator numbers and consequently negatively affects the agricultural production and biodiversity [6].

When speaking of visually dependent animals, global darkening problem occurs even in areas without light pollution, the skies are getting darker due to pollutants and greenhouse gases in the atmosphere scattering light [7].

Dominioni et al. [2] integrate knowledge of animal sensory ecology, physiology and life history to articulate perceptual mechanisms such as masking, distracting

and misleading, that explain the impact of anthropogenic sensory pollutants on organisms. Masking depends on the overlap in physical properties and intensity between the pollutant and target stimulus, for instance traffic noise that masks the birdsong. Distracting may occur between different modalities, for example sound as the pollutant and target being a visual cue. Misleading does not depend on the overlap in time and space between the pollutant and target stimulus, the example being artificial light at night, see figure 1.

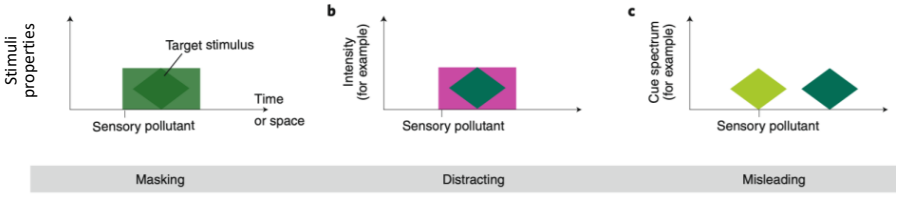

Figure 1: Mechanisms underlying ecological effects of sensory pollutants [2].

Sensory disruptions in coastal aquatic life may result from eutrophication, sedimentation, and contamination by metals and chemical pollutants from agriculture, pharmaceutical, and manufacture industries. Climate change itself leads to ocean and freshwater acidification and rising water temperatures. There is also discharge in marine environments of surfactants, stormwater runoff containing metal contaminants, bisphenol A coming from plastics, PCBs used in electrical industry, and PAHs. Also, to be mentioned is the auditory impairment, degraded optical habitats, as well as potential effects we do not know much about like electromagnetic fields such as underwater cables on electroreceptive fish and sharks [4].

Speaking of humans, all the more people live in environments that present the threat of sensory loss, such as urban areas, vicinity of intensive animal farming, industries displaced from cities, out-of-town waste management facilities, remote parts of wastewater collection systems leading to coastal submarine discharges, vicinity of highways, airports, or ship routes, marinas, noisy water sports equipment lease and use sites, etc.

Sensory ecology for humans has focused primarily on vision [8]. Our visual landscape has shifted from far to near vision in the built environment. Audition is also less tuned to the environment [5].

Environmental stressors among others include undesirable stimulators such as noise, vibrations, extreme temperatures, and, from the olfactory perspective, poor air quality and nuisance odours [6]. Sensory loss related health declines have been somewhat buffered by cultural interventions, but there is no buffer in the case of olfaction. Chemosensing, that is taste and smell, are ancient senses and the olfactory system is the brain's environmental probe [1]. Odours may be perceived without conscious awareness or higher brain processes, and they also evoke memories and

emotions [8]. Some air pollutants cannot be detected through the smell receptors, but they can be detected through the trigeminal nerve and these are judged to fall outside the traditional definition of an odour [6].

4. Human well-being and health

According to the Constitution of the World Health Organization [9] well-being is a fundamental human right, the highest attainable standard of health wherein health is defined as a state of complete physical, mental, and social well-being (not simply the absence of disease or infirmity). The associated health effects of sensory dysfunction encompass mental, physical, and social domains. Sensory disruption is a contemporary social problem, it degrades our quality of life, and is a costly healthcare and sick leave concern.

The knowledge about different senses is unbalanced and historically predestined prioritisation of senses prevails. Thus, vision and audition are given primary and secondary importance respectively. The sense of smell was considered to be "lesser" sense in the 17th and 18th centuries as a result of the tendency of differentiating humankind from the animal kingdom Normally, vision and hearing allow the distance between the perceived and the person that perceives it. Unfortunately, it happens that we cannot switch off our sense of smell as opposed to sight where a viewer can simply close his/her eyes and look away from an offending view. In other words, with sight we have the control, while smellscape keeps us immersed therein [6].

The demands associated with increased education and less time spent outdoors, meaning reduced exposure to natural light during growth and development are now causing visual malfunction, whereby the use of computers and portable devices is exacerbating the problem.

Current environment also provokes hearing loss. It is important to point out that about 60% of hearing loss are preventable, and 20% of individuals with hearing loss have been affected by loud noises of everyday living. As much as 24% of individuals with non-occupational hearing loss report they believe they have excellent hearing. In elderly the hearing loss leads to decreased cognition and imbalance which results in falls and social problems. In children language acquisition delays occur, as well as reduced economic and educational opportunities and social isolation. The production of hearing aids meets less than 10% of hearing loss needs [5].

Olfactory disfunction affects about 16% of the population. Although not yet considered an important sense by health professionals, there is an awareness of its vital function in everyday living [1]. Furthermore, the obesity in adults and children is associated with impaired olfactory functioning. Mental markers of olfactory disfunction are the depression and reduced quality of life and olfactory sensory inputs are crucial in creating environments that reduce stress. Neither corrective devices nor clinical interventions are available to offset loss of olfactory ability as is the case for myopia

and hearing loss, the only one being pollution reduction. The olfactory nerve is highly vulnerable due to its proximity to the external environment where it is exposed to the effect of accumulating pollution along the olfactory tract and consequently in neurodegradation after long-term exposure to pollution [5]. Marginalisation of smell is also evident in the fact that insurance companies value total loss of the sense of smell more than 3 times less than the loss of hearing and more than 10 times less than the loss of sight, while only taste is valued lower than smell [6]. Also, colour as the sensory cue for flavour expectations for food and drinking has been replaced by tools such as food labels, nutritive content alterations [5]. and additives which may also enhance its smell and taste.

On the top of that, the risk to our senses is not equitably distributed. Sensory inequities imply unequal access to healthy sensory environments and the inequitable distribution of resources to create positive and healthy sensory environments [1]. In 2022 the United Nations declared the access to clean and health environment a universal human right [10].

5. Coastal sensescape

Through various activities humans exert enormous pressures on coastal areas i.e. the sea/land interface on which they depend [11], and thus increase the threats to themselves. Besides chemical pollution of the sea, air and land, there is energy pollution such as air-borne and underwater noise, change of microclimate, greenhouse gas production which result in ocean acidification, change of air and sea temperature, seawater salinity oxygen content, sea level rise, storm surges, and hurricanes. All that has significant effect on coastal sensescape.

In terms of degradation of sensescape associated with humans, coastal visualscape is all the more affected by impaired views owing to intense and often inappropriate developments in coastal areas and use of space, converting natural and green areas into built spaces accompanied by exposure to excessive light and lack of shadows, as well as light pollution. Soundscape is dominated by traffic noise, nose from port activities, construction, pleasure crafts, music from catering facilities and beaches in concession, fireworks, and many other tourism-related activities. Smellscape is affected by traffic, but also catering activities, sewerage networks and wastewater treatment facilities, as well as waste management operations and infrastructure. Regarding haptiscape, the effect of use of non-traditional materials in construction may be singled out as well as impermeable pavements and the presence of plastics, while thermal feeling is affected by built areas, dwindling green land cover, and the increasing use of air conditioners which during summer cool indoor and additionally heat outdoor spaces.

However, just as Schafer in 1994 highlighted the positive role that sound as opposed to noise can play in environmental experience, smell and other senses also have a positive role to play in city life. Rasmussen in 1959 describes architecture and

city design as functional arts that should appeal as much to the ear as they do to the eye, mentioning material textures underfoot [6]. Coastal areas, even in their urban parts may preserve the smellscape of natural marine flora and fauna if the seashores are not fully modified by development, while the smellscape dominated by herbs also applies when patches of virgin land cover still exist within and around urban areas.

It is also important to point out that presently new building practices often result in homogenised, sterile and controlled environments or 'an alienating sense of place lessness', 'Global Catwalk' serving investment and tourism, which often ignores or intentionally overwrites local community use and place attachment, and thus a sensory deprivation [6]. Pedestrianisation itself may create greater differentiation in air quality between the pedestrianised areas and those immediately outside it which then becomes subject to greater pressure from displaced traffic.

Many catering premises are also generators of significant amounts of waste which also emits odours. It must also be borne in mind that evening economy and the spillover of catering facilities on public spaces, in combination with anti-smoking legislation, as well as sometimes inappropriate conduct of pet owners increased the quantities of waste and odour-producing bodily liquids in city streets. Furthermore, the businesses such as fast food and takeaway outlets which encourage the stopping and starting of vehicles and their running at low speed is problematic due to chemical and energy pollution. Ventilation systems direct the odours from food preparing facilities to public spaces to attract the clients or to backyards where the often undesired and unpleasant olfactory experience for tenants and passer-by's is incurred.

The trees and greenery ameliorate air pollution, odour, noise, and sometimes the scenery is often selected in a way to minimize foliage in order to improve traffic visibility and facilitate monitoring of the public via CCTV cameras. Such measures taken within the context of running the city come at the cost of sensory experiences of people inhabiting and visiting the city.

Finally, feeling of the place does not only imply visual experience of the environment, but is the sum and blend of sights, sounds, smells, taste and feel. Therefore, all the senses should be considered in designing, planning, investing, and policy making, taking into consideration both the „feels" of locals and tourists see also [13].

6. Sensory notation

Sensory notation tool introduced by Lucas [12] is a system of representation to aid urban designers and architects in creating environments which respond to our entire sensory experience of a place. Sensory notation uses a simple radar chart diagram to organise the information (figure 2). The chart has six axes, one for each perceptual system used. Six perceptual systems are the visual system (all effects of light, transparency and colour), the kinetic system (the movement of crowds, traffic, and the

notator), the chemical system (combining scent and taste), the aural system (all effects of sound as experienced, clarity, amplitude, pitch), the thermal system (hot and cold, wet and dry), and tactile system (touching materials, feeling ground textures through the feet). Corroboration, indicating how the senses overlap is shown using dotted lines.

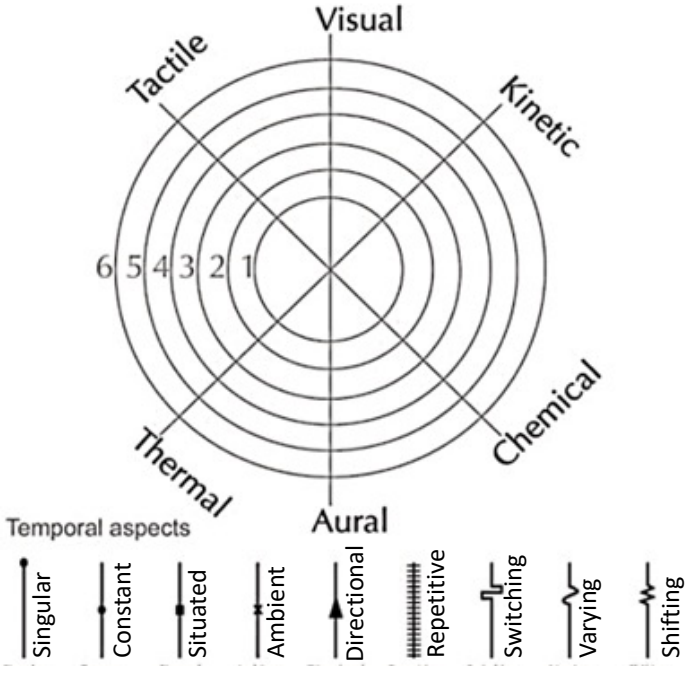

Figure 2: Sensory notation tool [6].

Figure 3 shows an example of graphic representation of the experience at market site in Rome. It depicts sensory priority where the length corresponds to the importance or dominance of the perceptual system, corroboration indicating how the senses overlap, uses the descriptors or words characterising each of the six perceptual systems, and shows the temporality.

In authors' opinion, this concept may evolve further, and it could be used for scoping and baseline studies in a way to upgrade the EIA procedures regarding sensescape. A sensory audit can be carried out to establish the existing qualities of a site. The flexibility of the notation also allows for integration of community experiences i.e., of the people who daily use a site and who may integrate their collective experience into proposals.

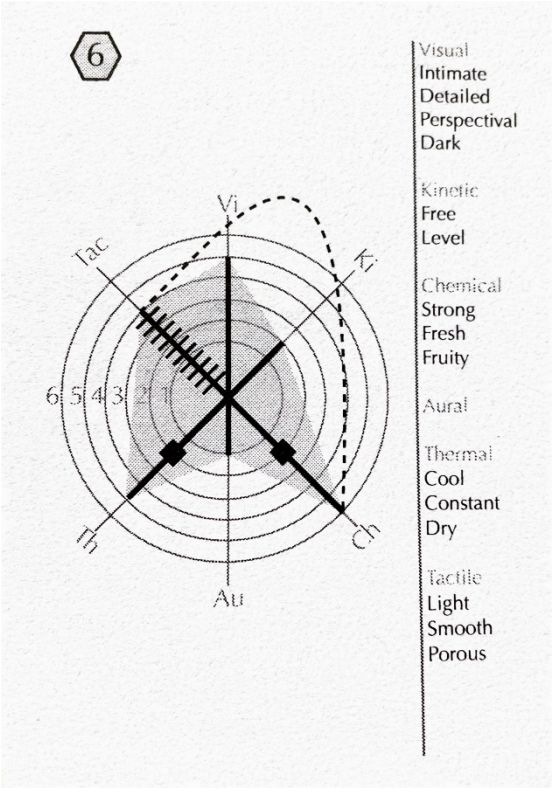

Figure 3: Sample sensory notation [12].

7. Conclusion

The response to environmental perturbations greatly depends on sensory systems whereby the experience is of the whole of the environment and therefore it should not be dissected into its component parts. The access to environments that foster wellbeing should be equitable, thus a necessity for material and material pollution reduction.

The policies should include planning for healthy sensory environments, particularly planting more trees and greenery as those contribute to sensory health.

All the senses should be considered in designing, planning, investing, and policy making, taking into consideration both the „feels“ of locals and tourists. Sensory notation could be an aid in devising ex-ante solutions and in raising the quality of coastal spaces.

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