Soundscape Transects: Case Studies from New York City and O'ahu

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ABSTRACT

A new method of linking both the aural and visual conditions of a soundscape is used to create transect maps across complex sonic environments. Two case study transects from New York City will be demonstrated: one comparing highway noise penetration in two adjacent but very different northern Manhattan parks, and the other spanning the width of the island of Manhattan at 75th Street encompassing the Hudson Riverfront park, the Upper West Side neighborhood, Central Park, the Upper East Side neighborhood, and the East River walkway. Another series of soundscape transect case studies from Hawaii's island of O'ahu demonstrates the impact of traffic noise at elevations ranging from sea level to over 800 meters (2,700 feet) high, captured along a variety of ridges across the island. In all of these case studies, having the directional audio information embedded in the extensive photographic field provides salient representations of the specific characteristics of the soundscapes under study.

Keywords: Soundscape, Cross-modal, Mapping, Aural Ecology
I-INCE Classification of Subject Numbers: 56.3, 68.3, 76.9, 79.9

1. INTRODUCTION

The cross-modal recording method used in these studies combines Ambisonic audio capture with high dynamic range (HDR) spherical panoramic photography (1), and is detailed in a separate paper being presented at Internoise2014 titled "WYSAHIWYG (What You See And Hear Is What You Get): Learning from photocartography in mapping the cross-modal features of the soundscape". This paper presents five case studies using this method to demonstrate the type of soundscape documentation which can be achieved for analysis and communication purposes.

These case studies take the form of transects—as defined by the Center for Applied Transect Studies, a transect is "a cut or path through part of the environment showing a range of different habitats (2)." In this soundscape mapping technique, a transect entails capturing an Ambisonic spherical panorama at several locations along a path which is traversed as a pedestrian. The pedestrian/recordist attends to the environment *in situ* and selects specific recording locations within the soundscape which exemplify the local characteristics and reveal salient complexities. After the recorded data is post-processed, the path and recording locations are marked on an interactive map which links to embedded audio and photographic data for exploration by the end-user.

The selected transect studies reveal the spectrum of sonic adjacencies present in urban, park, and urban park environments. In all cases, the sound of various motors—from vehicles, aircraft, or landscaping equipment—is shown to suffuse an alarmingly large geographical footprint. In some settings, such as the urban canyons of high-rise neighborhoods in New York City, the roadway sounds are in keeping with the visual expectations of the surrounds. However, in others, the roadway sounds are located at a significant distance (>1 km) and because the roads themselves occupy little, if any, of the visual field, the sounds manifest as a form of invasive species in the environment.

2. MEASUREMENTS & THE SUPPRESSION THEREOF

2.1 Calibration Procedures

This method emphasizes direct listening and viewing of cross-modal representations of the locations under study, and as such relies heavily on full-range recording techniques rather than

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numerical measurements and abstract metrics for descriptive purposes. However, it is important to conduct a few measurements for calibration purposes in post-processing.

The first numerical dataset required is geographical datalogging, which is achieved with a portable battery-powered GPS device that records the path traversed and also stores coordinates at recording locations marked by the user. Using freely available tools such as Google Earth (3), the GPS datalog is overlaid as a path with marked locations on a scalable 3D representation of the geography, which can then be used as the basis of the soundscape transect maps.

The brightness intensity range encountered at a location is measured using the camera's internal spot light meter. To compensate for the limitations of single-exposure contrast ratio, several exposures at different shutter speeds are taken to cover the entire brightness range present. The process of high dynamic range (HDR) imaging is then used in post-processing to generate imagery which corresponds as closely as possible to the summed experience of an eye's dynamic adjustments.

Maintaining an accurate sense of relative intensity levels across a soundscape transect requires a few additional steps during recording and post-processing. At each location, it is important to monitor the loudness levels on the recording device and adjust the input gain as high as possible while avoiding distortion. This ensures maximal dynamic range in the recorded audio with minimal noise. However, because we want to gain an accurate relative perspective between different soundscape locations in the final transect, the recordist should also use a sound pressure level (SPL) meter while recording. Most SPL devices allow the user to monitor sound pressure levels in real-time while storing the maximum level encountered. This max level is noted along with the gain settings of the recording device at each location. In post-processing, each location's audio is normalized such that the loudest sound of each recording registers as 0 dB. Then, the SPL measurements are consulted to establish the loudest location, with every other location's audio track being reduced by the corresponding number of dB SPL difference in the max measurements. Finally, using an SPL meter during playback to calibrate the volume of the loudest location will thus ensure that the relative intensity levels between the various soundscape locations are preserved intact for the end-users.

For more on the photographic and Ambisonic processing techniques employed, refer to the other Internoise2014 paper by the same author: "WYSAHIWYG (What You See And Hear Is What You Get): Learning from photocartography in mapping the cross-modal features of the soundscape".

Figure 1 – Left: author's custom cross-modal soundscape recording configuration comprised of Ambisonic audio capture and spherical panoramic photography. Right: AMOD AGL3080 GPS datalogger and Pyle Pro PSPL05R digital SPL meter.

2.2 Intuitive Data Presentation

Having thus balanced the photography's dynamic range and calibrated the relative levels within a soundscape transect, we can now shift focus from the measurements (which are the main focus of a typical noise map, often further abstracted as colors) to spatial exploration of the recorded scene through the linked multi-channel Ambisonic audio feeds and 360° spherical panoramas. Carefully constructing cross-modal media which presents reliable environmental representations, and then linking that media with an interactive map indicating geographical information, allows us to concentrate on the salient features and perceptual relationships experienced. The end-user can contemplate the complex soundscape issues directly, bypassing abstract data reductions.

The reader is asked to indulge this project's theme and recognize that this paper will serve only as accompaniment to the multimedia demonstrations to be presented at Internoise2014. Indeed, the very ethos of this work is to encourage soundscape mapping to move away from reliance on words and numbers for representational purposes in favor of WYSAHIWYG, and as such, cannot do full justice to the transect maps here. Therefore, what follows will function as brief anecdotal support of the specific soundscape transects under study, while a fuller demonstration will take place at the conference.

3. NEW YORK CITY TRANSECT: FT. TRYON & INWOOD HILL PARKS

Located at the northern tip of Manhattan, Ft. Tryon Park and Inwood Hill Park share a relationship to the Henry Hudson Parkway along the west side. However, the parks are quite different: Ft. Tryon is landscaped with open vistas across the Hudson River, and Inwood Hill has dense, old growth forest on steep terrain. Soundscape differences between these two parks exemplify the counterintuitive "mismatch" phenomenon, whereby traffic noise from the highway actually has more presence in the heavily forested Inwood Hill Park simply because visual expectations do not prepare one for the proximity to the highway. Visitors to Ft. Tryon Park, on the other hand, can see the highway below but also have expansive views across the river. Such visibility shifts the scale of expectations, effectively diminishing the presence of the highway sounds even though geographical proximity and sound pressure levels are nearly identical to Inwood Hill Park.

The transect recordings were captured at several locations in both parks which showcase different spatial relationships to the highway and Hudson Riverfront, including shifts in elevation above and below the raised highway. The park activity, highway traffic, and river access largely define the soundscape experiences of the small residential neighborhood located along the natural fault line that lies between the two parks.

The author was fortunate to also take recordings using the cross-modal capture methods inside artist Janet Cardiff's "Forty Part Motet" piece which was installed in The Cloisters Museum, adding an architecturally resonant set of three recordings situated within the larger northern Manhattan soundscape context.

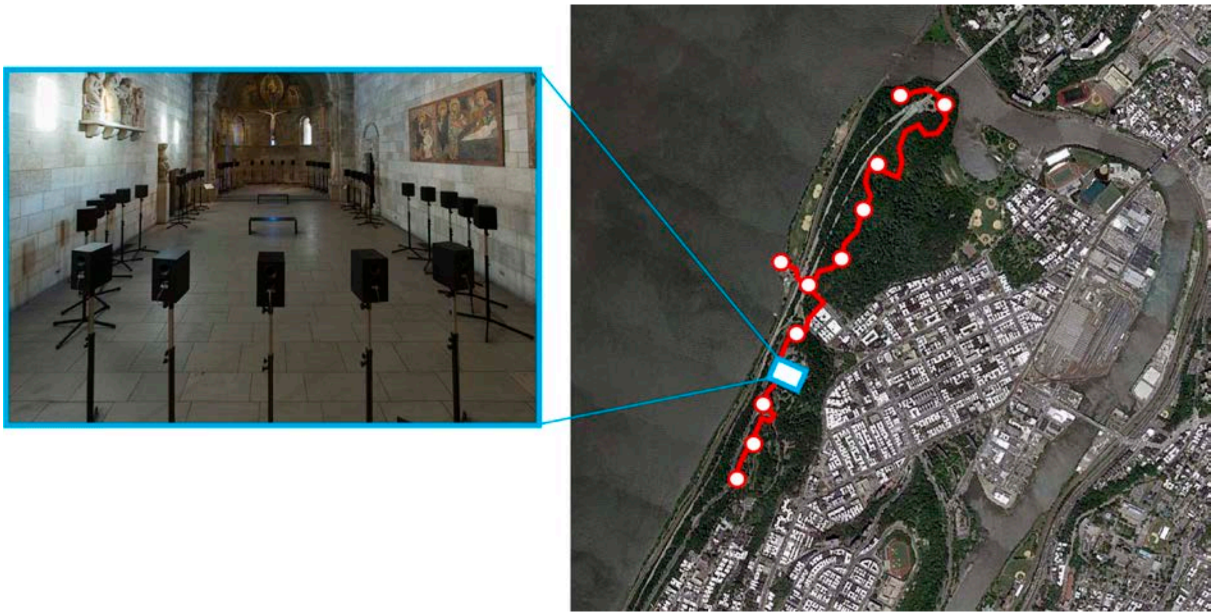

Figure 2 – Left: Janet Cardiff's "Forty Part Motet" installed in the Metropolitan Museum of Art's Cloisters Museum (image: Wilson Santiago); right: map of transect path with recording locations marked in Ft. Tryon Park and Inwood Hill Park (background image: Google Earth).

4. NEW YORK CITY TRANSECT: 75th STREET EAST TO WEST

This collection of soundscape recordings was captured along Manhattan's 75th Street from noon to midnight, starting at the East River waterfront and moving west through the Upper East Side neighborhood, through Central Park and the Upper West Side neighborhood (including the intersection with Broadway), to the Hudson Riverfront Park. The range of urban and urban park soundscape qualities is extensive, with several different relationships to vehicular sound throughout. The island's perimeter is defined by heavily trafficked highways abruptly alongside popular urban park renewal projects at the rivers' edges. Meanwhile, the high-rise residential neighborhoods between the rivers and Central Park possess markedly distinct soundscapes due to the small streets and acoustic "urban canyon" effects. Of course, Central Park is home to a diverse range of heavily populated park habitats with vestiges of the traffic grid penetrating into the park to various degrees.

The author was fortunate to obtain permission to collect three recording locations in and around Pauline Oliveros' "Deep Listening Room" installation at The Whitney Museum's 2014 Biennial.

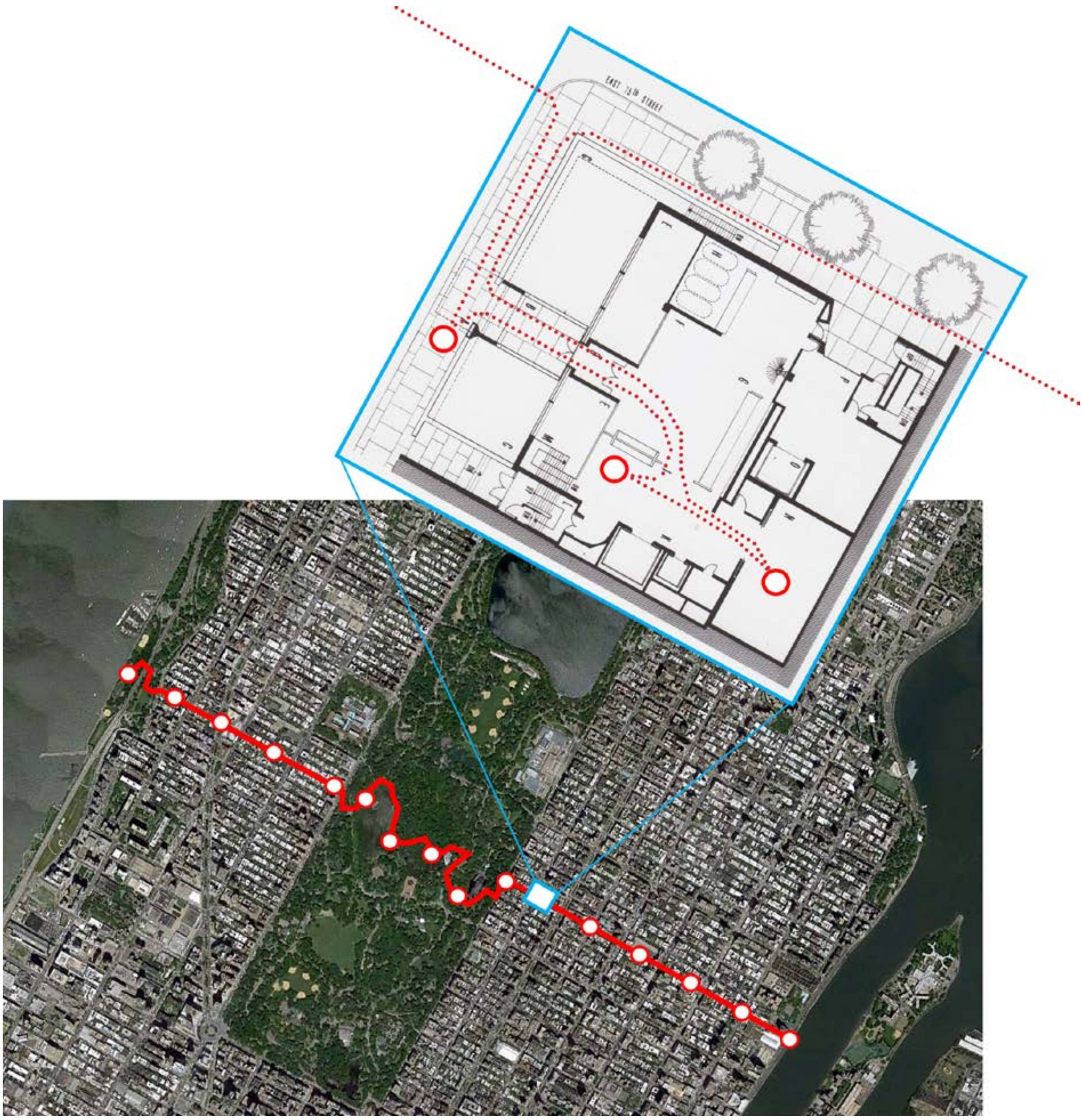

Figure 3 – Above: Marcel Breuer's floor plan of The Whitney Museum, which hosted Pauline Oliveros' "Deep Listening Room" installation in 2014; below: map of transect path with recording locations marked along 75th St. in Manhattan (background image: Google Earth).

5. O'AHU TRANSECT: KA'IWA RIDGE TO LANIKAI BEACH

On Hawaii's island of O'ahu, there is a charming community on the north side of the island, opposite Honolulu and Waikiki. Lanikai is a quiet, leisurely community nestled between the Ka'iwa Ridge and one of the best beaches on O'ahu. Traffic into the community is routed through slow roads, however sound from air traffic and landscaping equipment abounds during the day. For this transect collection, recordings were made along a ridge trail at varying elevations above the neighborhood, down at sea level in the central community park, and out on the popular beach where ocean sounds meld with human activity.

Figure 4 – Transect path with recording locations marked from Ka'iwa Ridge down to Lanikai Beach (background image: Google Earth).

6. O’AHU TRANSECT: KULI’OU’OU RIDGE TO PAIKO LAGOON

The Kuli’ou’ou Ridge Trail is popular for its climb through several types of forest up to an open peak which overlooks the entire southeastern portion of O’ahu, with vantages over both sides of the mountain range. The transect passes down into the valley community located between the ridges and the heavily traveled perimeter road below, with recording locations in the central community park and alongside the highway. Finally, another recording is taken on the other side of the Paiko Lagoon from the tip of a wildlife sanctuary, right on the ocean but still clearly within earshot of the highway.

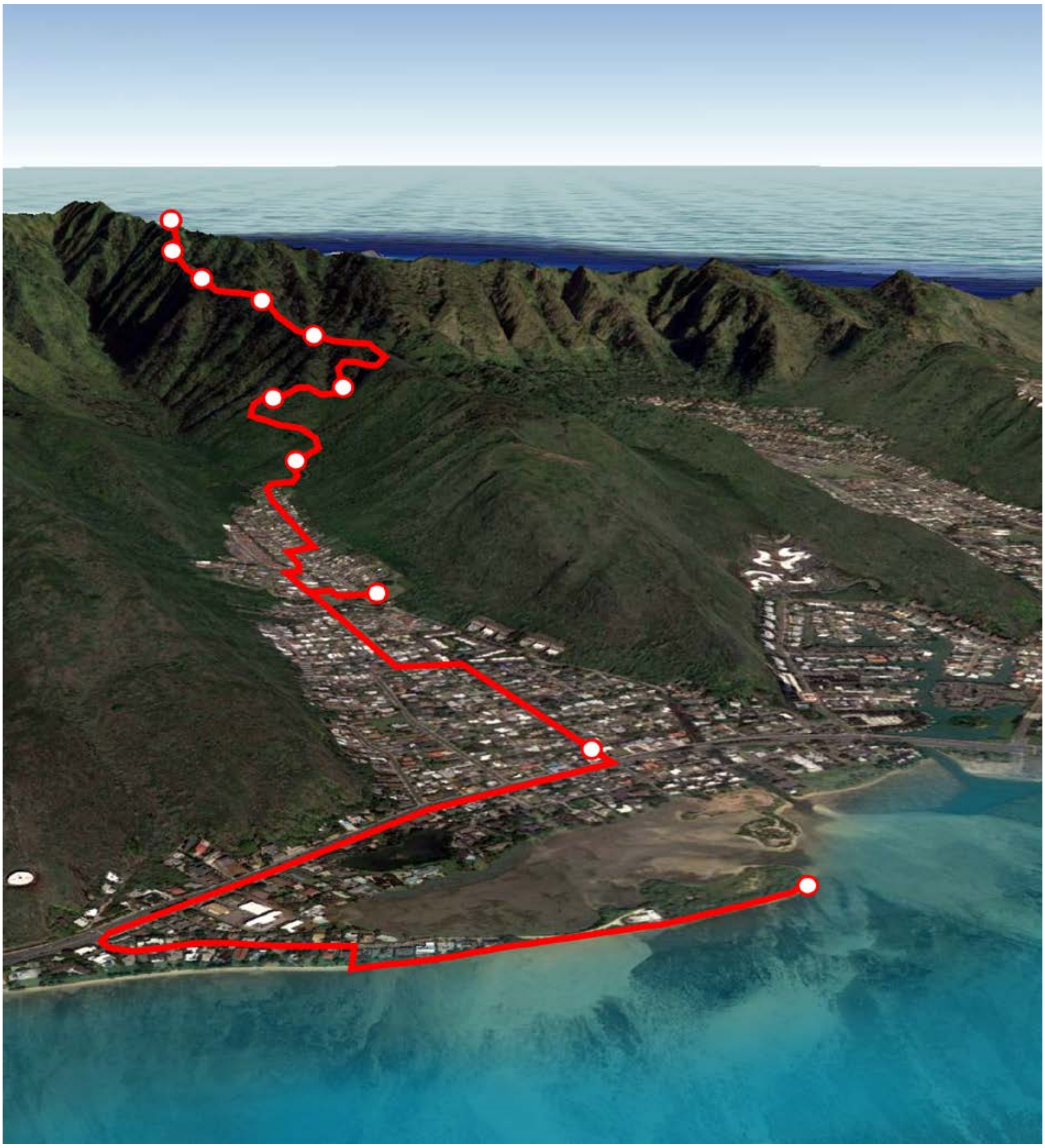

Figure 5 – Transect path with recording locations marked from Kuli’ou’ou Ridge down to Paiko Lagoon (background image: Google Earth).

7. O'AHU TRANSECT: HAIKU STAIRS

The Haiku Stairs are a short (~2 km) but notoriously difficult climb: nearly 4000 steps installed by the military in WWII bring climbers up 800 meters (2,700 feet) in elevation, nearly twice the height of the US's tallest skyscrapers! The sharp ridges fall away precipitously on either side of the stairs, affording sweeping views below and beyond. The heavily used elevated H-3 highway exits a mountain tunnel below and wraps around the mountain beneath the stairs. This arrangement presented a unique opportunity to record the highway sonic footprint at different elevations above the vehicles.

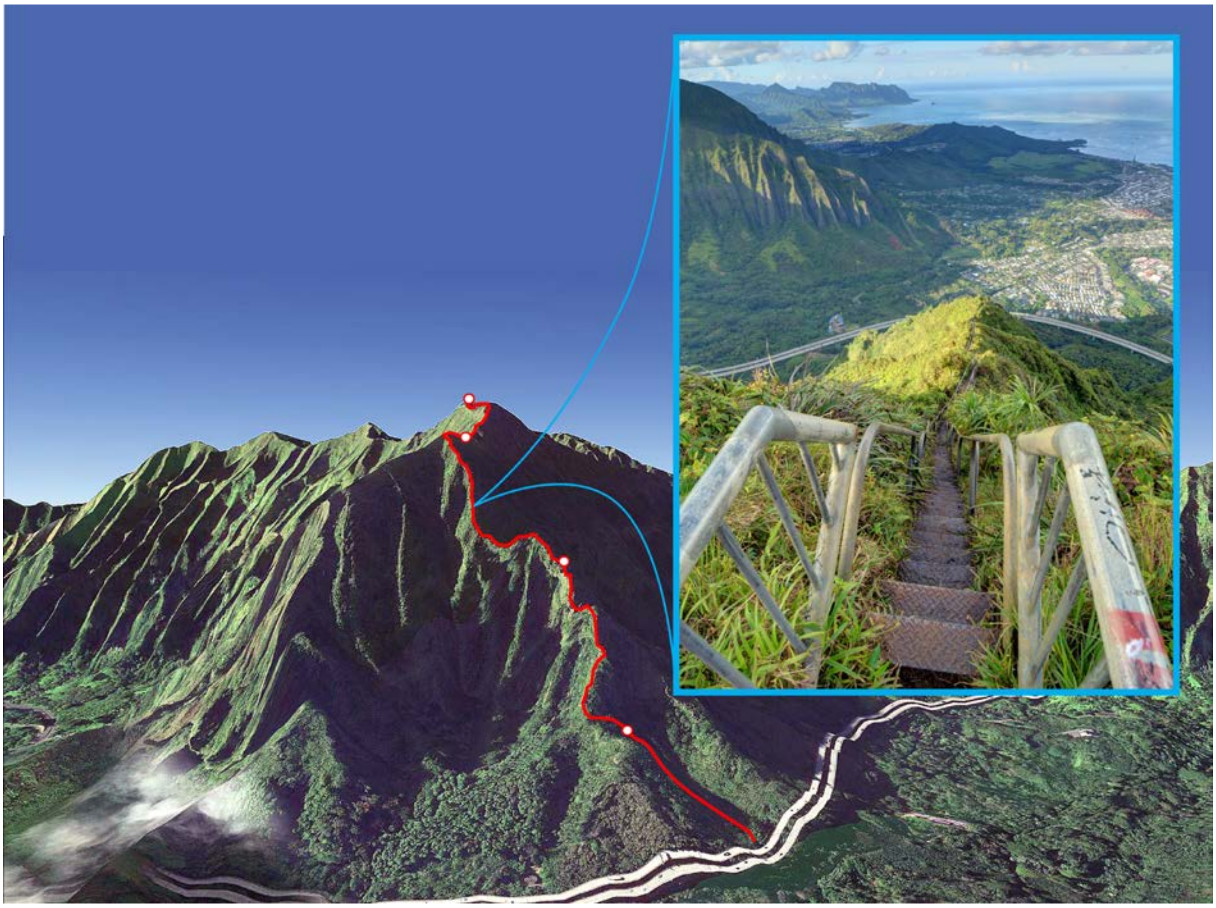

Figure 6 – Transect path with recording locations marked along the Haiku Stairs (inset image: author; background image: Google Earth).

8. CONCLUSIONS

The cross-modal soundscape transects presented here map a variety of environmental conditions where the built environment is enmeshed with the unbuilt environment ("nature"). Complex sonic—including dynamic, spectral, and spatial—characteristics are captured, and intricately interwoven acoustic/visual relationships are revealed.

The recordings document specific locations at specific times, and as such are not intended to represent the extensive characteristics of the soundscape, but rather afford a robust "snapshot" of the typical conditions. To deepen the documentation, one could apply these recording techniques repeatedly at the same locations to assemble a more comprehensive representation of the soundscape. Such a schedule of repeated recordings could span hours, seasons, or even years, and would provide a reliable soundscape representation if the calibration procedures discussed here are employed.

The direct display of audio and photographic material—without the obscurations of abstract metrics—makes these maps user-friendly for scientists and citizens alike, and promotes an emphasis on direct experience of the multisensory effects encountered in the soundscape (for obvious reasons, the interactive multimedia data cannot be reproduced within this paper format).

It should be stressed that the resulting collection of recordings and interactive maps are only half the value of conducting such soundscape transect studies. While there are current efforts to study environmental noise by embedding and networking standalone machine sensors—efforts which may yield useful data, albeit detached from other contextual factors and devoid of true *listening*—the unapologetic emphasis in this method is to place the burden of direct environmental observation on the pedestrian/recordist.

As scientists and researchers, it is a common temptation to work only with decontextualized machine data, to attempt to evaluate environmental conditions while humanly absent from the environment in question. In this method, the act of collecting data is at least as valuable as the datasets which result, providing the researcher with opportunities to witness counterintuitive effects first-hand and familiarize herself with those perceptual phenomena which tend to escape the capabilities of measurement devices. It is such phenomena, of course, which largely influence the subjective experiences that we attempt to legislate, plan, and design for. It should further be mentioned that conducting such field data collections frequently draws attention and curiosity from passersby—the opportunity to meet and speak with others while inhabiting the soundscape together is an additional, profound opportunity not afforded by typical lab work.

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