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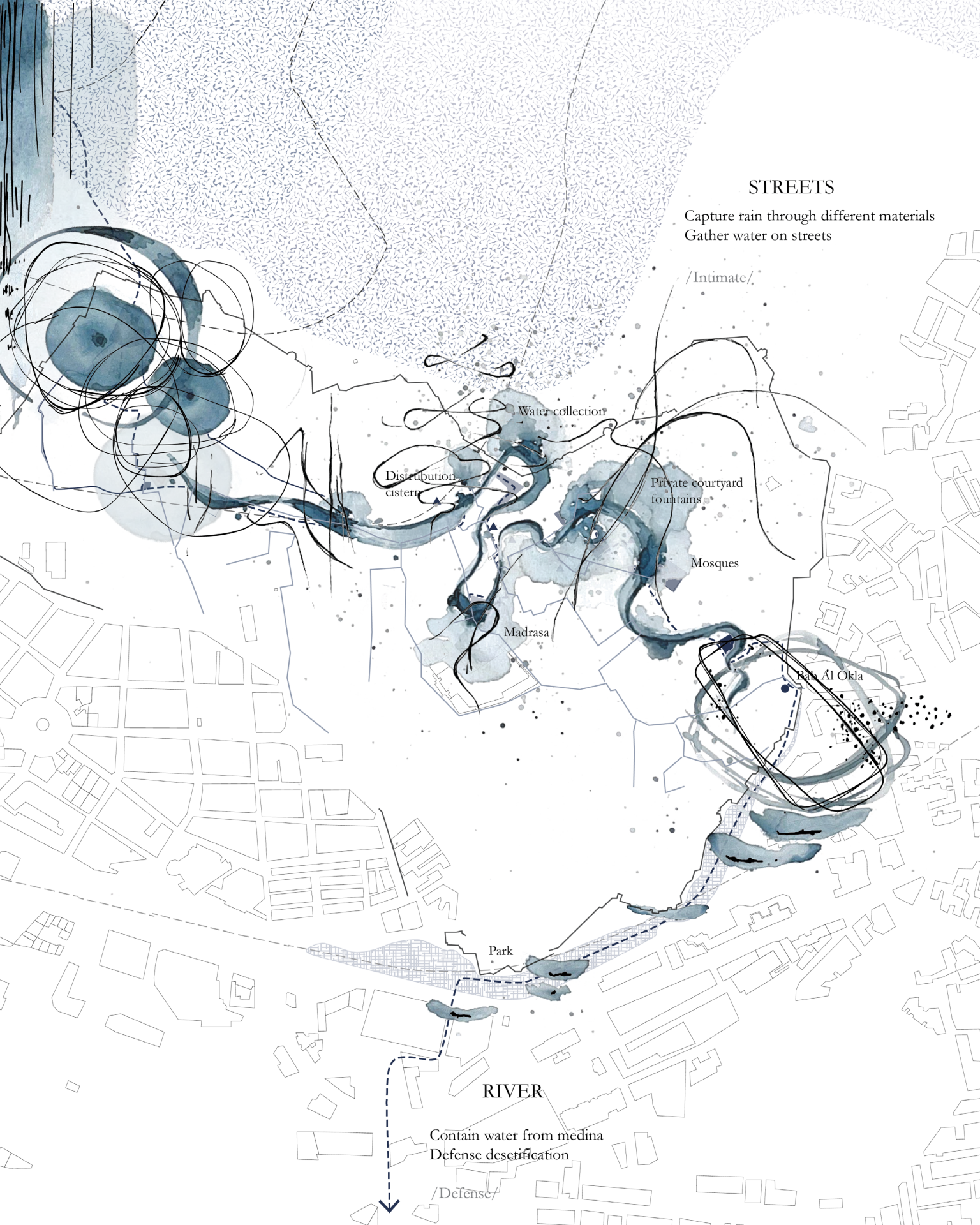
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STREETS
Capture rain through different materials
Gather water on streets
/Intimate/
Water collection
Distribution cistern
Private courtyard fountains
Mosques
Madrasa
Bab Al Okla
Park
RIVER
Contain water from medina
Defense desetification
/Defense/

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Designing with Sound as a Methodology to Reconnect Water, Culture and Heritage in Tetouan, Morocco

Regina Klinger, Nicola Vollmer & Aylin Yazici

Abstract
This paper explores the use of soundscape design to reconnect the people of Tetouan, Morocco, with their cultural heritage as embodied in their historic *skundo* water system. Our understanding of soundscapes within this context was developed through an in-depth soundscape analysis within the medina of Tetouan that identified how the *skundo* system and its audible sounds are still present. To amplify the presence of the *skundo* system and raise awareness of the value of water, we used the system's traditional clay pipes, with their audible and tactile qualities, as focal elements in our design interventions. Through the soundscape analysis, we designed interventions in several unique spaces that highlight the value of water within two possible future climate scenarios: one involving an abundance of water and the other its absence. Through these sound interventions, we aim to reconnect residents with their water and cultural heritage and emphasize the importance of sustainable water management while integrating local traditions.

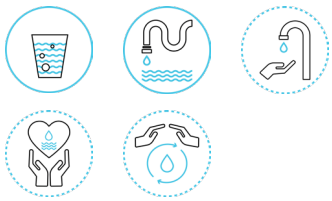
Policy Recommendations

- Prioritize the preservation and integration of traditional water systems to maintain cultural heritage while addressing contemporary water management challenges.
- Encourage local communities to actively participate in the preservation of water heritage through initiatives that raise awareness of the historical and cultural importance of water systems.
- Promote the use of innovative methodologies, such as soundscape design.

KEYWORDS

Skundo
Medina
Morocco
Soundscape
Water and cultural heritage

WATER ICONS



CLIMATE

A B **C** D E

Csa: Hot-summer Mediterranean climate



< Fig. 1 Masterplan soundwalk (Source: C. Chang, 2024).

Introduction

Tetouan is a historic city in northern Morocco located between the Mediterranean Sea, the Martil River and the Rif Mountains. This geographical setting creates an interconnected natural water system that has played an important role in shaping the city's development. The *skundo* system (fig. 2), a native network for transporting water, originates in the mountains to the north of Tetouan, where water is gathered and funneled underground through clay pipes, relying solely on gravity. These pipes not only transport water but also naturally purify it, making it a key resource in urban life.

The cleaned water flows first into general reservoirs and distribution points before reaching public taps, fountains, mosques, madrassas and hammams. After serving these critical communal spaces, the water continues its journey to the river and finally northward to the sea. The system exemplifies Tetouan's long-standing heritage of managing natural resources efficiently while connecting its people with the surrounding landscape, from mountain to sea.

Water, both physically and symbolically, plays a significant role in the local culture. In Islamic tradition, water represents purification, spiritual renewal and sustenance. Not only has the *skundo* system served the city's water needs, but it has also helped to create traditional and cultural places, meaning it is the literal embodiment of heritage. Traditionally, these waters and the rituals associated with them had audible qualities that were experienced as part of locals' everyday lives—they were seen and heard as the water sprang from the depths of the mountains, through the *skundo* clay pipes and out of the fountains into the medina, the "old walled core" of the city center.



^ Fig. 2 *Skundo* distribution system (Source: N. Vollmer, 2024).

However, the heritage and the presence of the *skundo* system have faded due to the dilapidation of this traditional water supply network and the commodification of water. The question that motivated our soundscape project was "What if you could hear the water of Tetouan again?"

For residents of the medina, water still shapes everyday life, whether it is part of preparing meals, brewing mint tea or performing ablutions. The communal act of collecting water from the public basins of the *skundo* system creates a sense of community. In addition, some individuals continue to embody the traditional relationship with water, preserving its significance for future generations. One such figure is "The blind plumber of Tetouan," whose unique ability to hear the water flow enables him to maintain the hidden *skundo* pipes behind walls and under the ground (Calder-

wood and Attwell 2010). His work is not only a practical necessity but also a reminder to the people of their historical ties with water and the importance of preserving their cultural identity. Even though the cultural significance of water remains through individuals like the blind plumber, as well as through common religious practices and daily routines, the system that connects people to their history has faded into the fabric of the city, due to the lack of water availability (New Arab Staff & Agencies 2022) and the modernization of the local water supply system (Strava 2024). This research-by-design therefore prioritizes the preservation and integration of traditional water systems to maintain cultural heritage while addressing contemporary water management challenges.

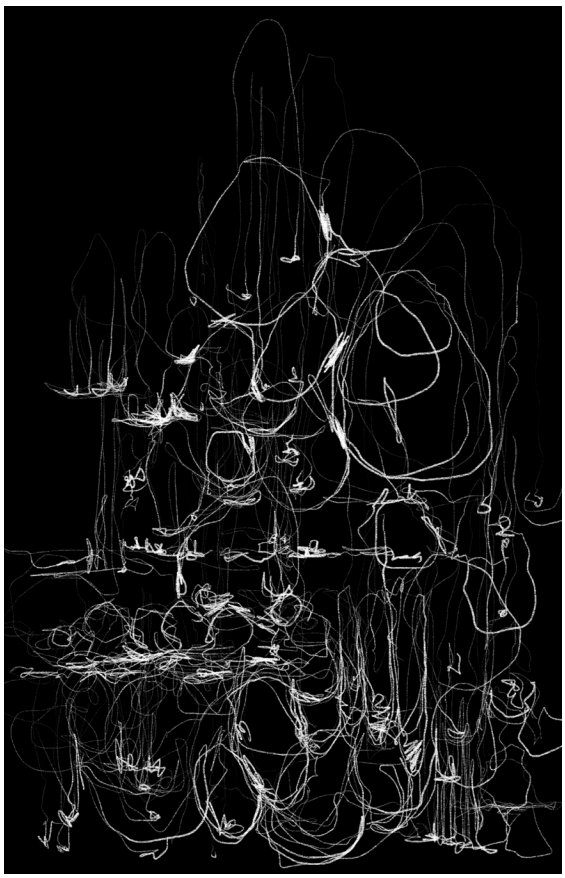
Like many places around the world, Tetouan is facing the urgent issue of climate change. Water scarcity is a growing challenge that raises concerns about how people will sustain their daily lives and traditions (El Bouenani et al. 2020). The region has already seen a decline in rainfall, with some studies predicting a reduction of up to 20 per cent in annual precipitation over the next few decades, which exacerbates the strain on already limited water resources (World Bank 2022). In addition, rapid urbanization and population growth in Tetouan are further increasing the water demand, making traditional systems like the *skundo* less effective (Alzahid 2024). In response to these pressing issues, the Moroccan government has announced plans to introduce modern technologies to improve the water infrastructure. However, these projects risk endangering the heritage of Tetouan by potentially replacing the traditional system with new piping (Arab Fund for Economic and Social Development 2024). This potential creates tension between modernization and the preservation of Tetouan's cultural heritage.

The soundscape methodology that we developed in this project was designed to address these issues by enhancing existing sounds of water and introducing additional audible elements within the city, thus encouraging local communities to actively perceive the relationships between water, culture and heritage. Through our sound design initiatives, we aim to raise awareness of the historical and cultural importance of the traditional water system. Furthermore, we want to promote the use of innovative methodologies, such as soundscape design, to reconnect Tetouan's residents with their water heritage on a perceptual level and foster climate awareness.

Analysis and Tools

To apply the concept of soundscapes as a method to reconnect water-culture-heritage in the medina of Tetouan, we used sound as a tool to explore the existing traditional *skundo* system that bubbles its way to the surface of the city. In May 2024, the Urban Archipelago studio briefly visited Tetouan. The experience of the audible waterscape revealed a force that lives in the Tetouan soil, connecting the residents with the workers, shops and mosques and the tourists with the locals and the animals. Listening closely to the sounds of water gave the impression that this lively water is a dynamic but often invisible driver that feeds the city and its workings. These existing soundscapes provided the foundation for our design interventions, which seek to make water's abundance or absence tangible through auditory experiences.

The *skundo* system is a carrier of stories, history and life from the mountain, through the city and out into the landscape of Morocco—an infrastructure that has shaped the medina (Benaboud 2024). The method of listening and

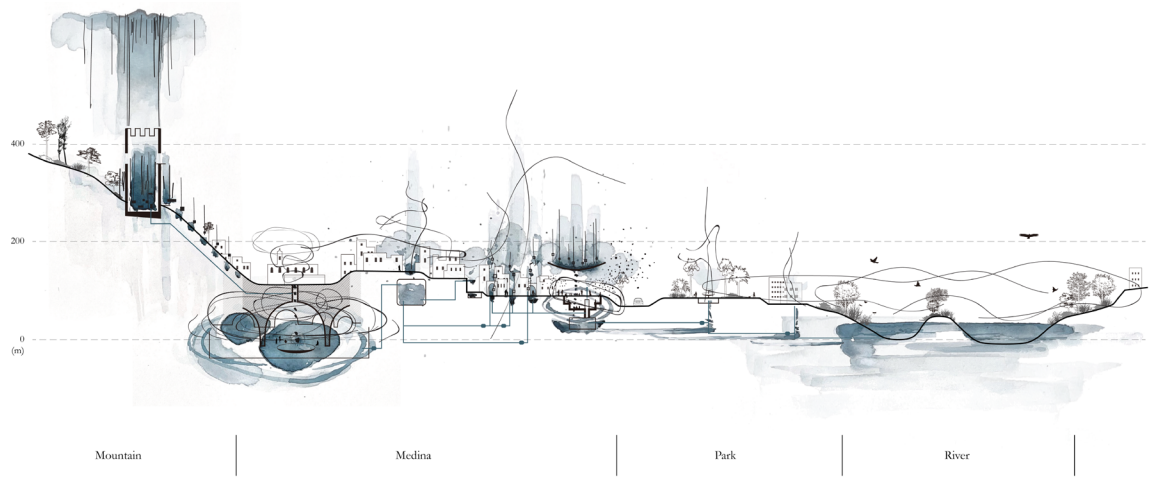


^ Fig. 3 Etchings and markings of a soundscape (Source: N. Vollmer, 2024).

tracing the sounds from the *skundo* became the lens of our exploration of the medina, including its people, practices and spaces, rendering the heritage visible and newly imagined within the city. We further linked the non-audible and audible flow of water to the existing and future climate conditions of Tetouan. Through an analysis of how the current climate conditions affect water availability in the medina, as well as a workshop on imagining extreme possibilities for the Moroccan climate, we developed two possible climate scenarios that we used to explore the experiences of the designed soundscapes. The first involves the abundance of water, which means long and extreme periods of rain and flooding. This climate exploration strengthens the connection between people, water and culture by allowing water (the abundance or lack thereof) to be the voice. Consequently, the second involves a lack of sounds (in this case related to the lack of water sounds), which means a condition of drought, lack of rain and possible sandstorms, as well as extended periods of heat.

Exploring soundscapes can be a daunting approach within a city with an unfamiliar language and practices and a potentially overwhelming blur of sounds, but our approach was to focus on the universal and familiar sound of water. For the first analysis layer, we were guided by the help of experts and locals to find where the *skundo* system showed itself through openings in walls, taps, fountains and private gardens and under the drains in the streets. In this way we were able to record the bubbling, trickling and plopping of the existing water that we found in the narrow streets of the medina.

The second layer of sounds that we extracted were the noises of people and activities within the context of the water source. What were people doing? Was it loud or silent? Was this a place of refuge or activity? A place of gathering, resting or working? By paying attention to the multiple layers of forces creating the existing soundscapes, we developed not only sections that visualized the physical creation of sounds, but also abstract drawings, etchings, scratches and markings, which represent our individual experiences of the city's sounds (fig. 3). These methods of extracting and interpreting the sound components made it possible to develop sound typologies that eventually sculpted our spatial design interventions.
Discovering the soundscape of Tetouan made us aware of connections that we did not origi-



^ Fig. 4 Longitudinal sequences of the soundwalk from the mountain to the river connecting to the subterranean *skundo* system (Source: C. Chang, 2024).

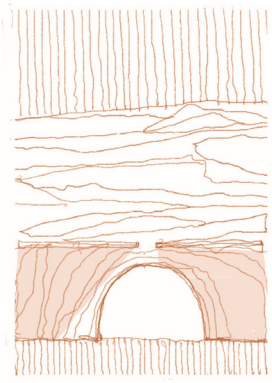
nally see or notice; it made us sensitive to what was creating these sounds and why. Through this analysis, we spatialized our findings into a tangible sound design representing the (non-) audible sounds of water flowing that inherits the narrative of the existing *skundo* system and aims to reinforce the water-culture-heritage relation as a circular system (once again).

Creating Audible Awareness

We translated our findings, represented by drawings, sketches and recordings of the voice of the water, into spatial expressions along a longitudinal sequence of public urban places. We created a soundwalk that narrates the journey of a drop from source (mountain) through the human scale (medina) to the outskirts (riverscape) (fig. 4).

We spatialized this narrative into a design based on the subterranean *skundo* system. While working with the existing sounds we mapped out, we then imagined new sounds according to the two scenarios of flood (presence of water sounds) and drought (absence of water sounds). The new sounds would then encounter the irregularity of urban sounds and the distant, passive bubbling of water sources that currently characterize the lively streets of Tetouan. Before and during the creation of a soundwalk design, several guiding questions helped shape our design approach: Which sounds will our design create in both scenarios, we wondered? How many design interventions should we include along the long line from the mountain to the river? How can we transmit a sense of climate awareness through the sounds we design? Which materials are suitable to create a sustainable and inclusive sound design that resonates with the people encountering it? And finally, how can we materialize these designed sounds in a way that they can be experienced alongside our recorded soundscapes?

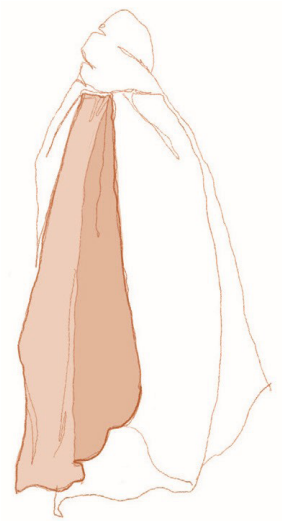
These questions were answered in different design locations along the soundwalk: The Dersa Mountains, the ruined barracks and former prison (fig. 5), the houses and ritual places of the people, the streetscapes (fig. 6) and the new marketplace (fig. 7). The journey of the water



^ Fig. 5 Concept mountains and barracks (Source: N. Vollmer, 2024).



^ Fig. 6 Concept streetscape (Source: N. Vollmer, 2024).



^ Fig. 7 Concept market space (Source: N. Vollmer, 2024).

continues then toward the outskirts of the city, where, after having collected enough memories and wisdom to access the outside world, it ends up in the river landscape that leads it toward the sea.

Part 1 of the soundwalk starts with the area of Tetouan that we experienced as "other-worldly" and distant, yet vital to the heritage—the Dersa Mountains (fig. 8). The first design intervention is located within the old ruins of the Jebel Dersa Tower (fig. 14), which will be reused as a water storage cistern that fills up during events of prolonged rainfall.

Through this design intervention we aim to make the water readable for residents: Once the tower has filled up to a certain height, the water will overflow through the existing openings and become visible on the outside in the form of a waterfall-like dripping and splashing. The sounds created will spread with the wind and the abundance of water will be audible and visible from the city. The water will then disappear underground and connect via pipes to the *skundo* system.

Further along the water's path, it seeps into the area of human settlement, crossing the boundary into the space where the people of Tetouan originally started to manage their surroundings and livelihood. Here the mysterious quality of the mountain meets the historically rich, robust and functional infrastructures that served the growth of the city of Tetouan (fig. 9). The design intervention for this area is located within the ruined barracks and former prison, which are currently hidden under the city (fig. 16).

In our design, the water drips into these caves and fills the new proposed water tanks located under the barracks, after which the water flows into the *skundo* distribution system (fig. 17).



^ Fig. 8 Proposed sound drawing of the mountain, with sounds characterized as "unearthly, echoing of rain, crashing and dripping, gushing, thunderous wind" (Source: N. Vollmer, 2024)



^ Fig. 9 Proposed sound drawing of the cave and barracks, marked by near silence and a heightened awareness of one's own heartbeat, with sounds characterized as "dripping of water and echoes" (Source: N. Vollmer, 2024).



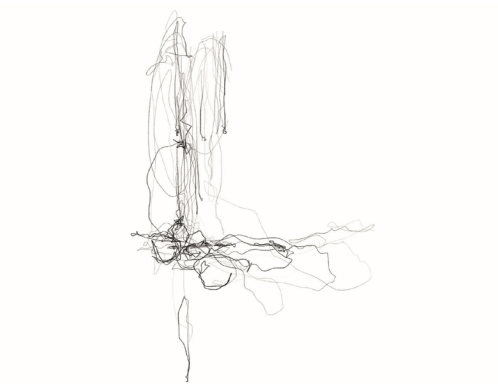
^ Fig. 10 Proposed sound drawing of the communal street, filled with social activity and interaction, with sounds characterized as "gathering, eventful, gushing and plopping, water on water" (Source: N. Vollmer, 2024).



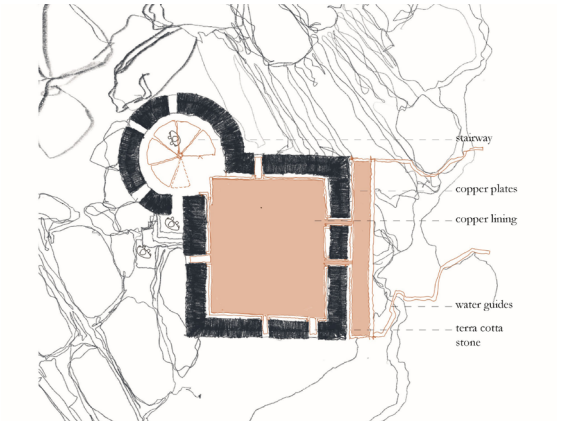
^ Fig. 11 Proposed sound drawing of the distribution cistern, establishing a sense of belonging, with sounds characterized as "rhythmic, moving, trickling from one to the other" (Source: N. Vollmer, 2024).



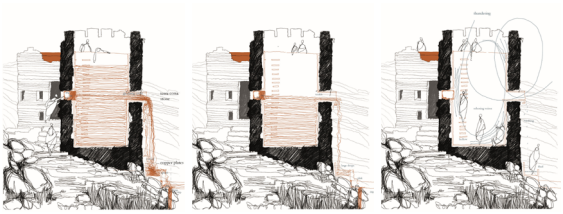
^ Fig. 12 Proposed sound drawing of the residential street, with sounds characterized as "rustling wind, movement of people, wind and water on fabric" (Source: N. Vollmer, 2024).



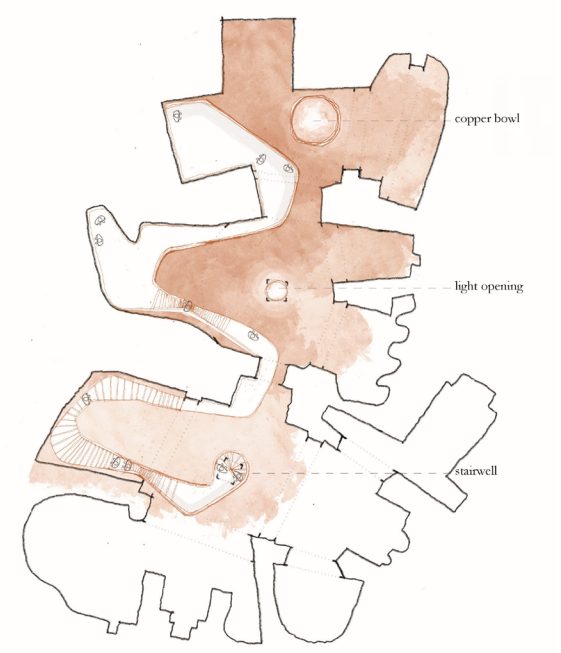
^ Fig. 13 Proposed sound drawing of the market square, with rich sounds representing people, market animals, talking, living, relaxing, overflowing water (Source: N. Vollmer, 2024).



^ Fig. 14 Floor plan of the Dersa Tower (Source: N. Vollmer, 2024).



^ Fig. 15 Dersa Tower in different scenarios (Source: N. Vollmer, 2024).

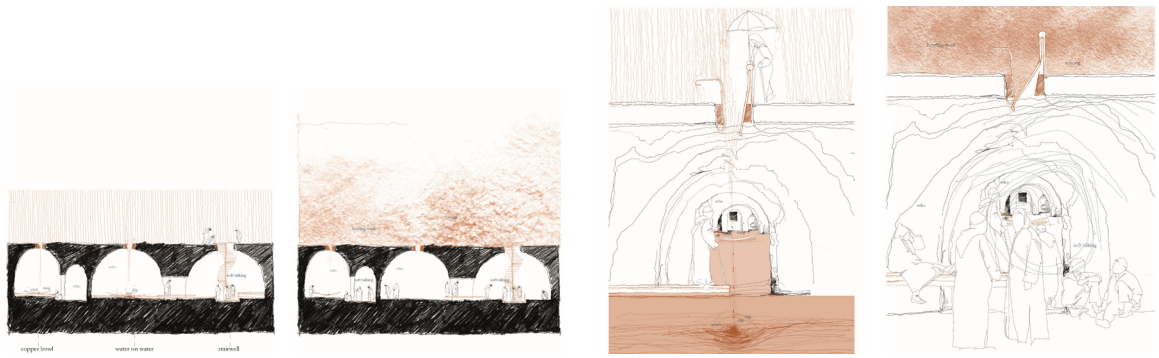


^ Fig. 16 Floor plan of the cave (Source: N. Vollmer, 2024).

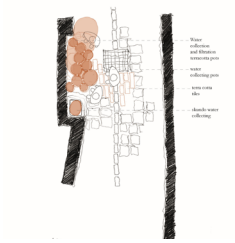
The purpose of the design intervention is to bring people back into this abandoned heritage space by making the caves accessible as cool spaces in times of extreme heat. The entire underground space is transformed into a water monument that captures discrete drops of mountain water and displays them as the central audible element. The sounds of the drops bounce off the resonating walls of this cave and form a gentle echo. The spatiality can also be experienced by listening to the drops crashing into a copper basin, which overflows with an abundance of water. The perceived sounds represent the solitude with which the prisoners lived within these caves and the hydrological stress of no – or little – rainfall.

In the second part of the soundwalk, the drop of water enters the human scale: the houses and cultural institutions. The water becomes part of personal narratives and rituals and therefore embodies the familiar and intimate sounds of the city (figs. 10, 11, 12). The water bubbles into the streets (figs. 18, 20, 22) and, together with proposed design interventions (figs. 19, 21, 23), it will make a valuable contribution to a rich sensory environment in which the inhabitants and visitors of Tetouan listen to the water with more awareness.

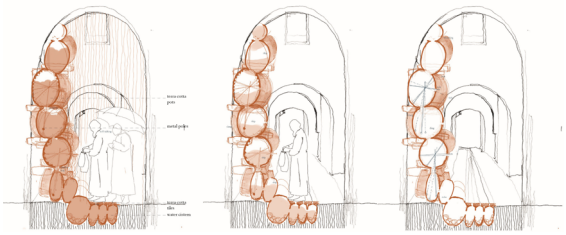
Our design makes visible springs and distribution systems that are currently hidden from the locals and passersby through small interventions such as tiles on the floor and openings in the wooden doors that allow people to find and listen to the water elements, while still restricting access to the critical infrastructure (figs. 20, 21). Along the streetscape, three spatial interventions will contribute to the sensorial experience of the sounds of water. Here, clay pots, tent fabrics and copper linings will mark existing places where these materials were once used, inspiring remembrance of their function



^ Fig. 17 The cave in different scenarios (Source: N. Vollmer, 2024).



^ Fig. 18 Floor plan of the communal street (Source: N. Vollmer, 2024).



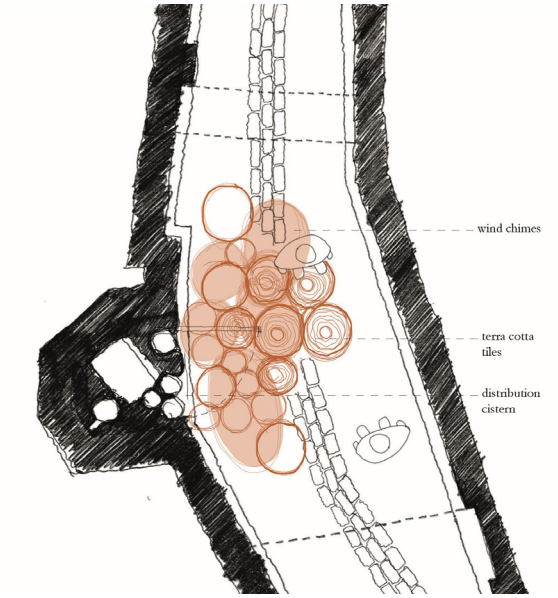
^ Fig. 19 The communal street in different scenarios (Source: N. Vollmer, 2024).

and meaning. Working with these materials in each of the locations, we create spaces for communal water collection (figs. 18, 19), spaces to gather around the distribution cistern and collect drinking water (figs. 20, 21) and spaces that work with the rainfall and wind, like the fabrics that give a rustling sound to the city's streets (figs. 22, 23).

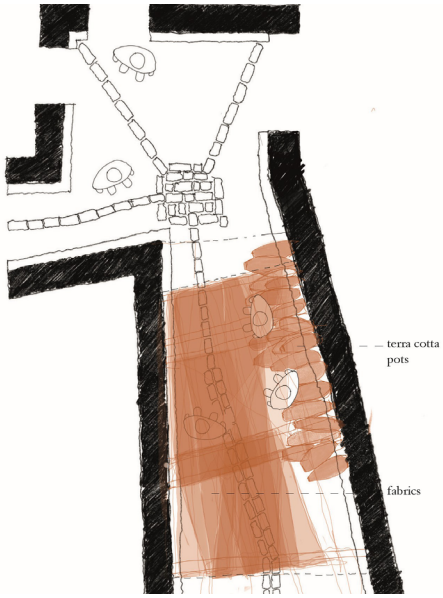
Toward the end of the medina, the water enters the third part of the soundwalk, the newly developed market square. This location resembles an accumulation of the sounds that we heard and gathered throughout the various medina streets (fig. 13). Here the pipes of the *skundo* system bring the water into a large overflow basin, which cools the square and brings the residents together (fig. 24). An overarching roof of fabric reaches over the square, letting light through but also directing water into clay pots, creating a place for locals and visitors to collect water. From here, the water exits the medina, ready to face the outside world of Tetouan (fig. 25).

The water gained knowledge, experience and stories by flowing through the sequences of the design, encountering people and their cultural practices. After this, it can enter the big natural reservoir – the river. From here it becomes part of the big sounds, exposed to flood and drought and going on a journey to tell the stories of the future. Our final step in designing the soundwalk was to make the intangible tangible by translating the sensorial designs, each with its own distinct spatial form and atmosphere, into clear architectural floor plans, sections and conceptual drawings.

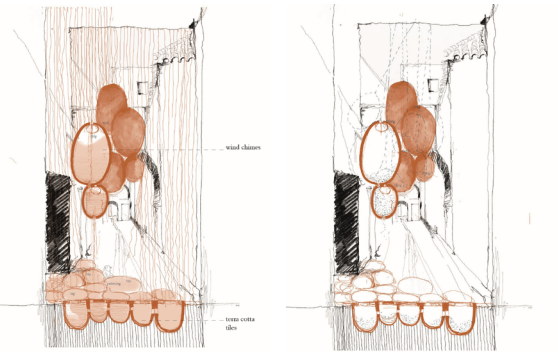
To make it possible for people to experience these architectural sound designs, we used sound creation software to design two versions of sound sequences and drawings that repre-



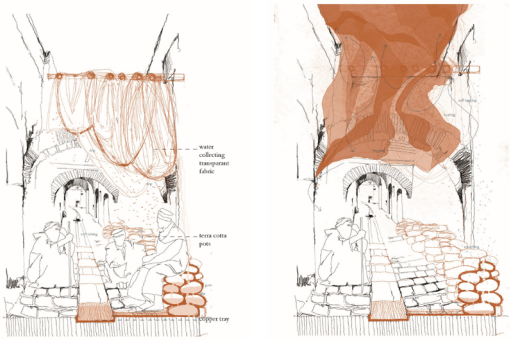
^ Fig. 20 Floor plan of the distribution cistern (Source: N. Vollmer, 2024).



^ Fig. 22 Floor plan of the residential street (Source: N. Vollmer, 2024).



^ Fig. 21 Distribution cistern in different scenarios (Source: N. Vollmer, 2024).



^ Fig. 23 Residential street in different scenarios (Source: N. Vollmer, 2024).

sent the audible features of the new spaces created. The first sound sequence represented the sounds of the soundwalk for the flood scenario, adding to the existing soundscape of Tetouan we recorded on the field trip. The second sound sequence represented the audible elements of the soundwalk during a period of long drought during which the sand of the Sahara takes over the city and creates sounds when encountering our designs.

After the two sequences were set up, we then recorded a video of the sounds being drawn by hand while simultaneously listening to our created audio recordings. Sound and sound drawings were then combined into a final video which represents the intangible.

In our design, the water-culture-heritage relation becomes circular again through the binding force of audible water flow between the people,

the abundance or absence of water and the heritage of the *skundo* water system. The residents become the stakeholders who function as "value-keepers," remembering the importance of the existing and perceivable *skundo* system.

Sound design video link: https://youtu.be/J37so_IdN88 (Source: R. Klinger, 2024).

Conclusion

While water remains vital to daily life, its direct connection to heritage has diminished in the present day. Modern interventions often disregard cultural and historical dimensions of water, such as Tetouan's *skundo* heritage. By analyzing the historical significance of the *skundo* system and employing sound as a tool for spatial design, our exploration of the *skundo* system's role in the city has demonstrated how traditional water infrastructure can be revitalized through design, reinforcing the importance of preserving and integrating such heritage within contemporary water management strategies. Through our engagement with Tetouan's urban and social infrastructure, we observed how community-driven participation strengthens the cultural connection to water, emphasizing the need for awareness initiatives that involve local stakeholders. Additionally, our methodology highlights how soundscape design serves as an innovative tool for making water heritage tangible, fostering a renewed sensory and spatial understanding of its presence in the city.
We recommend that any use of soundscape design to make water heritage visible, should focus on sustainable practices by utilizing local materials, such as clay in the case of Tetouan, while addressing contemporary challenges. Engaging with stakeholders and the local community is essential for fostering a renewed appreciation of the system.

Our approach faced limitations: Specifically, time constraints prevented in-depth engagement with the local community. Future research should incorporate participatory methods to ensure residents are involved in the conversation and decision-making processes. The integration of their perspectives ensures that the cultural significance of water is preserved and celebrated in the face of changing environmental conditions.

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