Living in Bio-Climatic Layers: An Investigation of Cappadocian Caves in Relation to Today's Design and Its Futures

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This exploratory paper discusses a primary study on Cappadocian caves' bioclimatic performance, speculating on its application to today's and future Performance Oriented Architecture (Hensel 2010; Hensel 2011; Hensel 2013). It is a rough initial pre-study to future broader research, claiming the need and relevance for in depth investigations. As too little has been done in this field, the project seeks to demonstrate how layering of spaces in relation to material and building techniques may manipulate different peals of exterior, semi-interior and interior spaces' climates in onion principle in respect to its use (Davidová 2016a; Davidová 2016b) and different species' habitation (Davidová 2016b), discussing its contemporary and future potentials for architectural practice on the work of Collaborative Collective's examples (Collaborative Collective 2012; Collaborative Collective 2016). The paper argues for fully adaptable architecture, that is full part of and in constant coexistence with its surrounding ecosystem. Thematic GIGA-mapping (Sevaldson 2011; Sevaldson 2012; Sevaldson 2015) was used as an analysing tool for systemic relations of collected registered data, as well as existing information, merging hard data with tacit knowledge (see Figure 1). The map shows air flow passing through different layers of spaces as the most important factor of the climatic conditions, depth and height location as a second one. This is all interrelated in co-existence to the use of the spaces. Here it seems that symbiosis of humans and other species can play a crucial role in climate comfort and both mentioned vary over time. Therefore, we believe, that due to recent fast climate and society change, with expected weather extremes (Czech Republic Ministry of the Environment and Czech Hydrometeorological Institute 2015; Republic of Turkey Ministry of Environment and Urbanization 2012; Flæte et al. 2010; Richardson 2010), transformative adaptive architecture should be investigated with the use of biology: reconfiguration as a new form of recycling.

1. Introduction:

1.1 Caves Topic Introduction:

Figure 1: a/left: Combination of Subtrative and Additive Technique on Traditional Wine Cellar in Znojmo, South Moravia, Czechia – these generate constant climate for white wine fermentation about 7-15°C (photo: Davidová 2014) b/ right: Traditional Wine Cellar in Znojmo, South Moravia, Czechia Largely inhabited by Algae - according to the wine grower the algea helps to generate the targeted climate and algaeless cellars don't perform well (photo: Davidová 2014)

Subtractive techniques in design play its role through all its history. Within architecture, carving of the ground - soil or rock; the subterranean architecture is first known from 3000 BC from Gazer, Palestine (Kempe 1988) and can be found all over the continents (Vegas et al. 2014). It ranges various different climates, such as i.e. temperate oceanic climate of England, continental monsoon, humid subtropical and continental climates of China, temperate continental or cold semi-arid climate of Turkey or Spain, hot-summer Mediterranean continental in Mesa Verde, Colorado, warm desert climate in Tunisia, cold desert or cold semi-arid climate of Iran. Today for its addressing city heat islands favoured additive ground techniques with use of vegetation have been used in Scandinavia, ranging from humid continental to subarctic climates. Combination subtractive and additive technique has been used in warm regions of temperate continental climate in Eastern Moravia, Czechia for regulating internal climate of wine cellars (see Figure 1). It seems that calcite is the most common mineral occurring in caves, but there are more than eighty different minerals listed, such as gypsum, ice, aragonite, the hydrated iron

oxide goethite and the manganese mineral birnessite coming after that (Kempe 1988). Its internal life both, flora and fauna, are extensive subjects in biology, especially genetics and environment adaptation of living organisms. Due to high humidity, caves are often inhabited by algae (Kempe 1988) (see Figure 1). Dolotov is mentioning the usage of an existing cavity as the most ancient way known to mankind and mining and backfilling (created volume is covered with an artificial roof and backfilled with the ground) coming after that (Dolotov 2015).

Supporting the basic needs such as living, work and protection, underground/cave settlements offered bioclimatic advantages (Vegas et al. 2014; Kempe 1988; Heba et al. 2012), using great passive design concepts (Kempe 1988). Cave dwellings were grouped in three main general types by Vegas et al. as: cliff cave spaces, built into the sides of cliffs (A), pit cave dwellings, normally built on flat land with pit areas open to the sky (B), mixed dwellings, constructed either above ground or thanks to a semi-subterranean solution, using cliff and/or pit cave dwellings (C), and finally a hybrid solution is also possible, thanks to earth-covered structures (D) (Vegas et al. 2014). Certain typologies in relation to climate and/or location, such as earth-mound, rocky and underground earth shelters; with or without courtyards are very roughly discussed by Khodabakhshian, Mofidi and Habib in their case study for Iranian earth - architecture (Khodabakhshian, Mofidi, and Habib 2012). Generally, it seems that so far, the systemic relations of climatic spatial distribution in historical subterranean dwellings initially carved by humans are if - than only mentioned. Not really investigated. Many more studies in such field have been performed on termites' settlements when it comes to natural ventilations and thermoregulations systems, such as Korb's and Linsenmair's study (Korb and Linsenmair 1999), that serves as endless inspirations to contemporary sustainable architecture and environment engineering.

1.2 Cappadocia's Case Introduction:

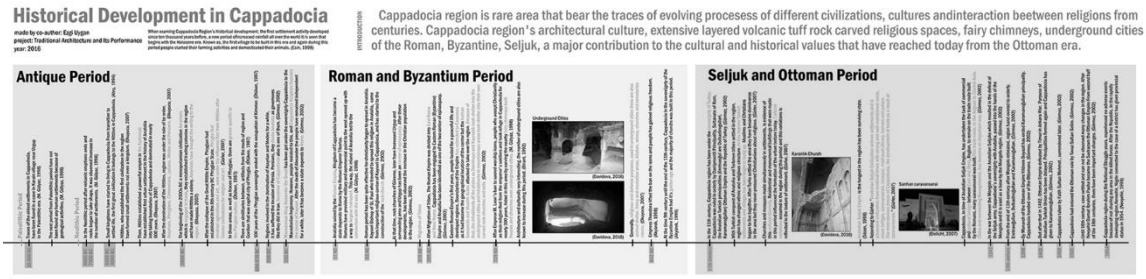

Figure 2: Time Line of Historical Development of Cappadocia (Uygan 2016, photos: Davidová 2016 and Elelicht 2007, information source: Akyürek, 1998; Görmez, 2002; Gülyaz, 1998; Gürler, 2007; Nevşehir, 1998; Okuyucu, 2007; Ötüken, 1987; Sözen, 1998)

First settlements in Cappadocia are registered from the Palaeolithic era around 10 000 BC (Gülyaz 1998; Esin 1998) when the increase of rainfall all over the world and thanks to that, farming appeared (Esin 1998). Larger settlements took place in Neolithic era (9 000 – 7 000 BC) after the end of volcanic eruptions when the rocks took shape (Gülyaz 1998). Since than Cappadocia was dominated by Hittites, Assyrians, Phrygians, Cimmerians, Lydians, Medes, Persians, Assyrian, Romans and Turks (Abidik 2013) (see Figure 2).

The literature sources on first dating underground cities differ but as it seems obvious they were carved with iron tools they couldn't appear earlier than in third millennium BC. Many hypotheses suggest the first to be built by Hittite or Phrygian. The underground cities in Asia Minor are proved by literature since 5th Century BC but the only concrete evidence about which the scientists are sure is that the greatest development in the underground settling culture in Cappadocia was between the 6th and the 16th century A.D. (Ayhan 2004).

After Migration of Tribes at 375 AD, The Roman Empire was divided into East and West Rome at 395 AD. Cappadocia has been engaged to Eastern Roman (Byzantine) Empire and Anatolia has been identified as one of the two centers of episcopacy. Eastern Roman Empire used tolerate different religions. Afterwards Sassanids and Muslim Arabs started attacking the region. Therefore, the inhabitants of the plains as Derinkuyu and Kaymaklı took shelter into the underground cities and inhabitants in mountainous areas took shelter into their own carved rock churches and cells (Görmez 2002). In 725, after Emperor III. Leon's ban to sacred worship icons, people who accept Christianity as their religion fled from the emperor's soldiers and took refuge in Cappadocia for nearly 300 years, hided in this area bycarving the nearby fairy chimneys built houses and churches even underground cities (Gülyaz 1998). The masonry houses in today Cappadocia are not older than 250 years (Kıvılcım 2011).

1.3 Today Subterranean Architecture Introduction:

It has been mentioned that today's rejection of earth sheltered buildings comes for the reason of higher costs of building methods for this solution (Kıvılcım 2011). However, Benardos at all.'s case study proves that next to the approximately 8% extra building costs, such buildings can have about from 30 to 40% lower energy consumption (Benardos, Athanasiadis, and Katsoulakos 2014). According to Devrath, contemporary earth sheltered buildings have great advantages as following: a) an earth-sheltered building is less susceptible to the impact of tremendous outdoor air temperatures, b) long life expectancy due protection from external factors, c) low maintenance, d) fire resistance, e) increased comfort because of minimal temperature swings, f) temperatures inside the building are more stable than in conventional building, and with less temperature

unevenness, interior rooms seem more comfortable, g) recycled materials may be used in their construction without problem, h) because earth covers part or their entire exterior, earth-sheltered buildings require a lesser amount of outside maintenance, such as painting and elevation treatments, i) constructing a building that is dug into the earth or enclosed by earth builds in some natural soundproofing, j) earth sheltered building "blends" the landscape more harmoniously than a conventional building and as a result provide more space for landscaping k) It provides natural safety and security to the building, l) space above the earth sheltered buildings remains available as open space (Devrath 2014). Different approaches of recent architecture's relation to ground, ranging from landscaping to earth digging and covering, is discussed by Hensel and Turko in Grounds and Envelopes publication, stating that historical burrowed settlements require much more extensive analysis before they can serve as a source for contemporary design (Hensel and Turko 2015). Well-designed ventilation seems to be designed in Future-Systems house in Wales from 1994. The weekend retreat house is fully set into the coastal landscape with a glazed 'eye' facing the sea (Margolius 2009) towards west and small windows toward east. See images at IDEASGN (Future Systems 2013) for a reference. Different recent underground dwellings such as SeARCH's and Christian Müller Architects' Villa Vals in Switzerland (SeARCH 2009; Villa Vals 2010) are elaborated by Vegas et al., arguing for its bioclimatic virtue (Vegas et al. 2014). This research seeks to motivate further research on different climatic layers for habitation, reached through spatial organisation in relation to material's penetration - insulation and natural ventilation, investigating traditional dwellings as a study source.

2. Primary Study on Cappadocian Caves and Underground City Performance:

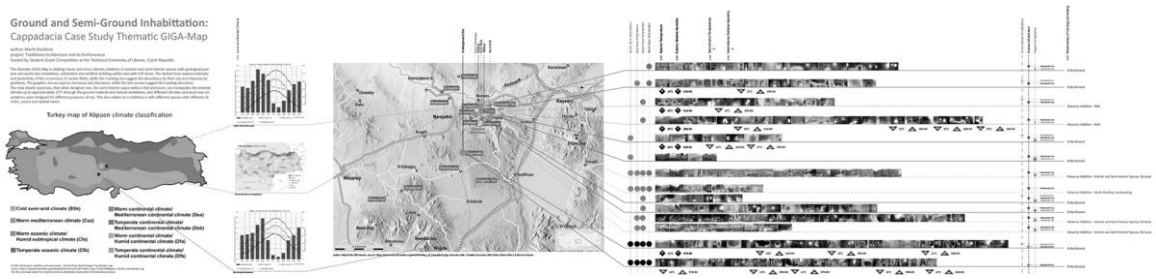

Figure 3: GIGA-mapping of Performance of Cappadocian Caves and Underground City (map by Davidová 2016, images of caves by Davidová 2016, Turkey map of Köppen climate classification has been used under creative common licence (Zifan 2016)*, Map of Cappacocia has been used under creative common licence* (Dörrbecker 2009)*, Climate and Temperature Diagrams used from Climatemps.com with expired copyright in 2015* (Climatemps.com 2015b; Climatemps.com 2015a)*, Climate Zones Rainfall in Turkey map used with the courtesy of Fanack* (Fanack 2016)*)*

Systemic relations of Cappadocian caves were GIGA-mapped (see Figure 3), confronting measured local exterior and different layers of semi-interior micro climatic and macro climatic data, geological formation and location, word's axis orientation, position of the weather station, the settlements visual information, relationship of carving and adding material and frequency of habitation by which specie. The images cover subliminal relations that recall the gained tacit knowledge. GIGA-mapping (Sevaldson 2011; Sevaldson 2016; Sevaldson 2015) is analysis and design graphical diagramming tool (Davidová 2014a; Davidová 2016b) used in Systems Oriented Design methodology (Sevaldson 2013b; Sevaldson 2013a), that was introduced by Sevaldson in 2005 (Sevaldson and Ryan 2014). This might involve both, hard and soft systems data (Sevaldson 2015). This is a thematic GIGA-map, connecting mainly observed data with published references in obvious architectural performance relations. Unfortunately, not enough investigations could be measured in better complexity. There are a lot of particular studies of certain phenomena, but though very interesting, they are even less complex than this one, usually comparing two features.

Cappadocia is located on the border of temperate continental and cold semi-arid climate zones (Zifan 2016) and between dry and very dry zones when it comes to rainfall (Fanack 2016). However, it has dry and hot arid conditions in summer and cold winters with snow (Kempe 1988; Demir 2015; Kıvılcım 2011; Climatemps.com 2015b; Climatemps.com 2015a). The precipitation peaks in spring, followed by autumn (Climatemps.com 2015b; Climatemps.com 2015a). In the time of measures, the start of May 2016, the climate was hot arid during the day, with rainfalls or very humid and cold late afternoons and nights.

Kempe relates to wooden windows/shutters on inhabited caves in Göreme in 80es (Kempe 1988) It is still possible to find some even now. Today, this is mainly replaced by contemporary windows and the spaces are equipped by regular heating. However, many spaces had been enclosed just partly such as in Çavuşin Monastery (see Figure 4). According to locals, caves were regularly rebuilt over time for different purposes and users, inhabiting pigeon's houses i.e. (see Figure 4). These were located in higher parts of the dwelling connected by ventilation shaft with human lived spaces (Demir 2015), by humans. The human – pigeon symbiosis had utter necessity for use of pigeon's droppings as rich fertilizers of otherwise infertile environmental conditions for agriculture (Kempe 1988). Thus pigeons reached better living standards through human cave architecture based on ventilation and widely reproduced. Rich pigeon abundancy can still be seen in the pigeon caves in recent times. Such spaces have warmer climate that is naturally ventilated but not easily accessible. On the contrary, farm animals were occasionally kept in the first accessible space of both caves and underground cities, which is proved by carved lugs for their bounding (see Figure 4). This clearly shows that this case was already not a symbiosis but exploitation. Some

caves are inhabited by black coloured algae, but this was so rare that its mapping couldn't propose any speculation on relations to other discussed topics.

Many caves were also enclosed by masonry in the same material. Many of these still in use, such as city of Göreme, have been enlarged with brickwork spaces and terraces with various levels of openness for low extreme seasonal uses, while caves are inhabited in cold winters and hot summers for its bioclimatic reasons (Kıvılcım 2011; Kempe 1988; Demir 2015) (see Figure 5).

Underground cities served only for refuge purposes, when the community had to stay for several months (Demir 2015; Hensel and Turko 2015) but it didn't serve for regular habitation. Erguvanlı and Yüzer categorized their factors as follows: 1) Severe daily and seasonal changes of temperature in the region, 2) thermal isolation properties of the rock units covering the region, 3) self-supporting behavior and construction opportunities of rocks, 4) easily carved, particularly soft tuffs, 5) defensive advantage and safety against enemy attacks for hiding and camouflage, 6) superior resistance and protection against natural disasters such as earthquake and/or volcanic eruptions (Erguvanlı and Yüzer 1977).

The spaces' climates were dependent on its height position and distance to ventilation shaft. As such, its use was organized according to climatic condition, where for instance 7-15°C is the temperature for white wine fermentation and 21-25°C for red wine. Özel explain layering of the spaces in Derinkuyu as follows: 1) the first level consists of stables, a winery, missionary schools and a baptistery; 2) the second level includes kitchens, food storages and related units; 3) the third level is constituted by a tunnel that connects the upper levels to the lower levels; 4) the fourth level contains living rooms, bedrooms and food stores; 5/6) the fifth and sixth levels act like distribution spaces with different ventilation tunnels which are also used as connecting corridors; 7) the seventh level is the most spacious space which includes a church and a burial chamber together with a great central meeting room; 8) in the lowest level there is a water channel (Özel 2014). On third and fourth floors were tunnels, interconnecting different underground cities among each other (Özgür Mutlu 2008).

Unfortunately, there is not enough map and table information on the sites and one has to rely on popularized rough talks of the tourists' guides, if available. Yamaç and Tok started their project on mapping underground cities within TAY Project (TAY Project 1998) through OBRUK Cave Research Group in different layers space (Yamaç and Tok 2015), but this does not communicate the complexity of not levelled 3D. Only the St. Eustachius underground settlement and partly Meryemana church In Göreme seems to be 3D scanned (Andaloro, Bixio, and Crescenzi 2013; Andaloro, Pignatale, and Verdiani 2013), but these data are not yet available. The uses are almost nowhere marked. It is still sometimes possible to collect family memories of the old caves owners as a source, which will most likely disappear with the coming generation. For this reason, uses of the spaces as well as spatial maps, as not being neither complete nor unerring, were not mapped, just the frequency of their inhabitancy in reference to particular specie through its typologies characteristics discussed with locals and guides or observed and guessed through literature study such as Cappadocia: Cradle of History (Demir 2015) and the photo documentation, as also being argued for as a crucial source by Andaloro et.al. (Andaloro, Bixio, and Crescenzi 2013; Andaloro, Pignatale, and Verdiani 2013). All the microclimatic data were measured in different layers with different air penetration options of not fully closed spaces or in adjacent exterior.

The temperature differs in reference to its depth and height of weather station position, material mass – rock/brick work and, most importantly, distance to ventilation stream (see Figure 6). It was measured to be about in maximum 15°C lower, when there is up to 8% higher relative humidity in the caves and 14% in underground city nearby ventilation stream, than the ambient exterior climate. Towards the north is higher occurrence of pigeon dwellings that might support better ventilation of higher temperature by its other properties, while human habitation is more common to sunny sides, preferably to south, but this is not the rule. It seems that farm animals were placed rather according to easy access than in relation to word axis orientation. The spaces for permanent use have generally higher temperature which, at least when the measures were taken, was securing excellent climate comfort. It was observed, that the word axis orientation and the size of the openings doesn't play too big role in climate control, even when exposed to direct sun, unless the ventilation equalizes this. But not all the spaces are equipped with ventilation in case of caves.

The measures were only taken in Zelve Valley and Kaymaklı underground city. More investigations need to be done to evaluate the relation of climate control and geological formation – material mass.

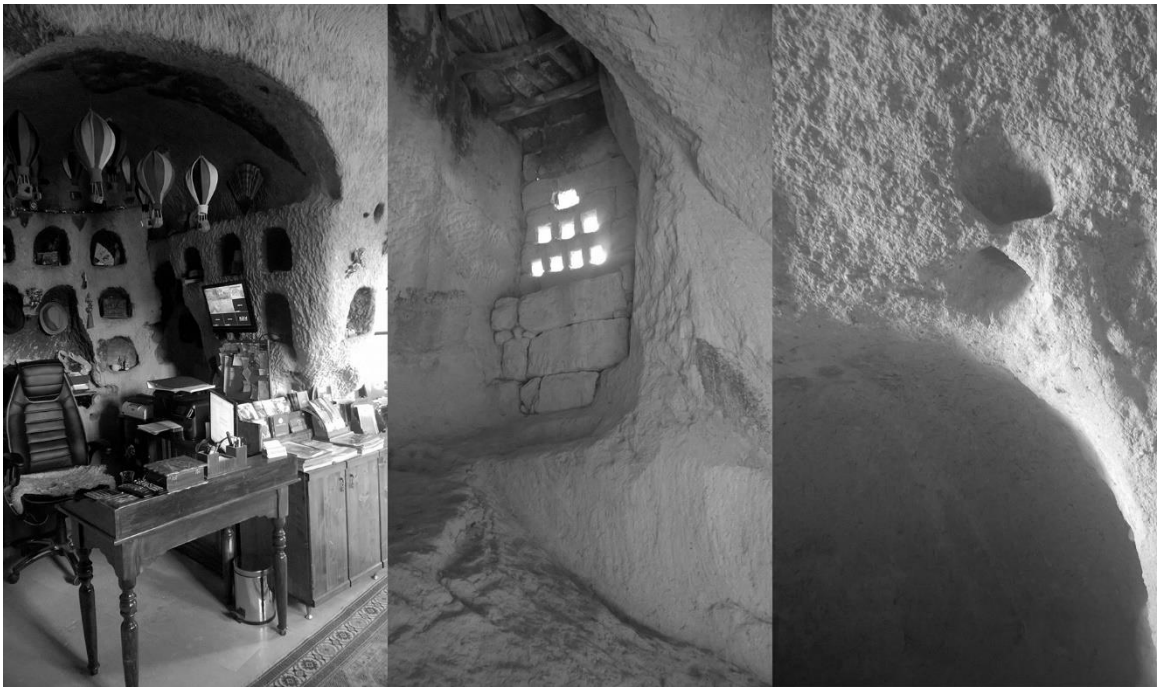

Figure 4: a/ left: Former Pigeon House that Was Rebuild into Dwelling, Today Serving as Hotel Reception, City of Göreme (photo: Davidová 2016); b/ central: Former Pigeon House that Was Rebuilt Çavuşin Monastery Interior Space (photo: Davidová 2016); c/ Carved Lugs for Farm Animal Bounding in Göreme Open Air Museum (photo: Davidová 2016)

Figure 5: Combination of Subtractive and Additive Building Techniques Developed over Time for Seasonal Use in Still Inhabited City of Göreme (photo: Davidová 2016)

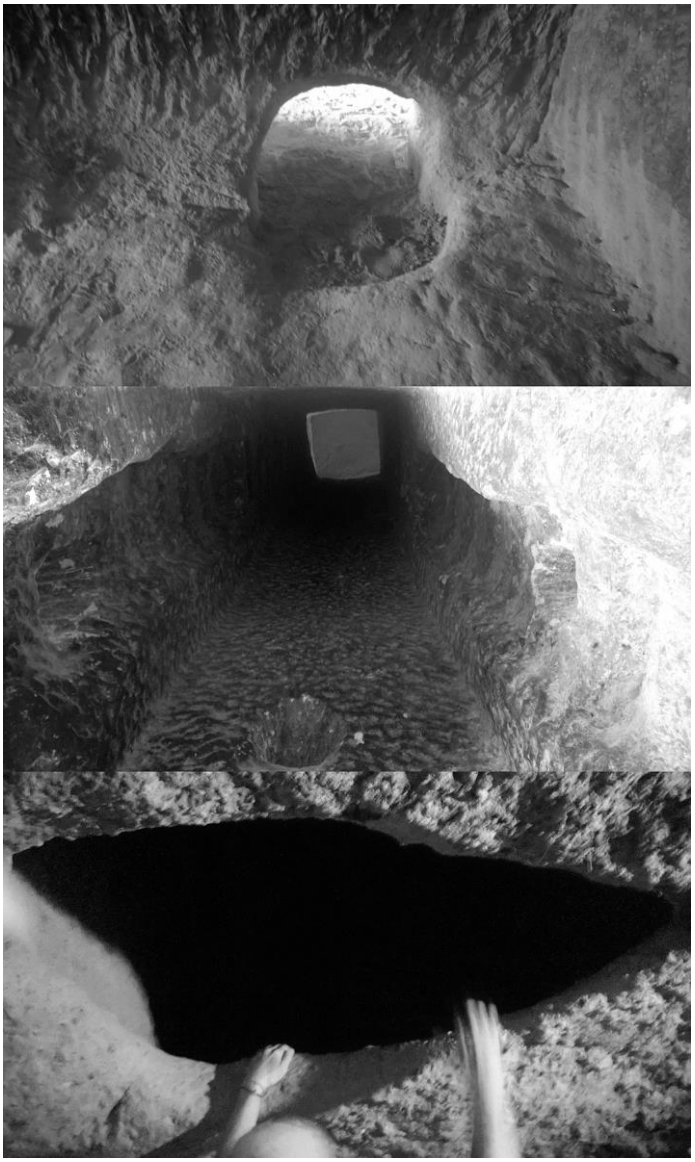

Figure 6: a/ top: Cave Ventilation in Göreme Open Air Museum (photo: Davidová 2016); b/ central: Cave Ventilation in Zelve Open Air Museum (photo: Davidová 2016); c/ bottom: Ventilation Shaft in Kaymaklı Underground City (photo: Davidová 2016)

3. Applications by Collaborative Collective:

The above study of subterranean architecture's performance was initiated by the first author's questions opened through her work in her practice Collaborative Collective (Collaborative Collective 2016; Collaborative Collective 2012; Davidová and Sevaldson 2016; Davidová 2013c; Davidová 2016b). The two following examples, one recently realized, one competition entry, show today use of discussed performance in reference of contemporary building standards/habits. Arguing for their change, generating more peals of climates in onion principle (Davidová 2016a; Davidová 2016b), addressed by Hensel and others as non-discrete spaces (Hensel 2013; Hensel and Turko 2015). The recent requests for natural ventilations, mainly discussed in reference to termites' dwellings (Korb and Linsenmair 1999), seem to have long history also for human kind, as well as the cohabitation with other species that can be found in almost every vernacular architecture. The advantages for the individual for crossing the boundaries of their groups were explained by Braden (Braden 2012) and they seem to be clear from researched case study on Cappadocia. The eco-systems are dependent on both, living and non-living factors that generate environmental performance. These factors are also targeted as a user experience, motivating a social change.

3.1 Spiralling Slope – Villa in Troja, Prague, Czechia:

Started in 2011, the recently realized villa project in Troja (see Figure 7), Prague is composed as a helix with central roofed, but ventilated and lit atrium, screwed into a steep south facing slope of Vltava valley. Nearly one third of the house is in the ground, while the top is covered by the ground with accessible green roof. Unlike grass roofs in Norway with higher occurrence of rainfalls and relative humidity, local thyme that grows in dry climates was selected, not requiring irrigation. In the same time, it regulates high water gains through short terms extreme rainfalls that are recently present due to global

warming. The private rooms are enclosed along the girt of the helix, except the south facing, roof shaded, fully openable to exterior terrace living-area, creating continuous space with atrium that connecting all more or less discrete rooms with staircase and build in ramp. Thanks to the sloping spatial organization, natural ventilation of the house is secured, while great energy usage and insulating material is saved through the ground. Partly glassed roof of the atrium, performing as a chimney, might become subject to humidity condensation, therefore algae will be grown on its concrete walls. The dwelling covers four different climatic and secret peals: 1) the full south side and roof openable continuous space of terrace, living room and atrium, serving as natural ventilation and communication corridor, that is securing living in symbiosis of human and algae, 2) south face and small side windows ventilated private bed-room and office with access to terrace or green roof respectively, 3) private children rooms with regular openable windows to east and 4) the underground service spaces opened by the garage entry to east by the end of the helix.

The different climatic environments are operated through sensors, regulating the enclosures of the openings. The first author's recent research is proposing primary energy control environment-wood material responsive screens Ray, ventilating in hot dry and closing in humid cold conditions (Davidová 2013b; Davidová 2014b; Davidová 2013a; Davidová 2016a; Davidová 2016b), regulating both, the interior as well as the exterior humidity by hygroscopicity of the material, generating real bio-climatic situation.

Figure 7: Relationship of the Ground and the Villa during Building Time (Collaborative Collectice 2014)

3.2 På Vei – Museum of Vernacular Arts and Crafts in Sogn and Fjordane, Norway:

This competition entry from 2011 (see Figure 8) was the initial motivation for above mentioned Ray research project. The in rock carved design with green roof is layering 1) exterior ramping path way with the view into 2) an unclimatised ramping gallery space, edged by 3) climatised, but not insulated administrative spaces, lit and ventilated by fans and roof windows. 4) The attached depository's climatic control is secured by partial placement into the ground and partially its layering on top of it, while regulating interior relative humidity by unfired bricks and wood. The building is fully part of the landscape and existing eco-system, including the human body based phenomenology of walking the path (Merleau-Ponty 2002). The unclimatised gallery space, that requires climate control for its exhibits, could be well operated by screen Ray and penetration from climatised, insulated by ground, administrative spaces (Davidová 2016a; Davidová 2016b). The ground on top with the local grass has not only insulating performance, but also landscape water and vegetal coexistence properties, regulating the extreme rainfalls and in the same time supporting human understanding of being part of adjacent ecosystem.

Figure 8: På Vei – Competition Entry for Museum of Vernacular Arts and Crafts in Sogn and Fjordane, Norway - Axonometry, Detail Section and Sections (Collaborative Collective 2011)

4 Discussion:

The future development of underground buildings due to its bioclimatic advantages is envisioned by Vegas et.al. (Vegas et al. 2014). The today application analysis by Benardos et.al. suggests great reduction of energy consumption that incomparably pays back the increase of building costs (Benardos, Athanasiadis, and Katsoulakos 2014), this seems to be true also with the examples designed by Collaborative Collective. Increase of green surfaces is called for by the Strategy to Climate Adaptation for Czech Republic Environment (Czech Republic Ministry of the Environment and Czech Hydrometeorological Institute 2015) due to Urban Heat Islands (Urban Heat Island 2016). It might be possible that the fertilization of the ground by old Cappadocians might have had, next to the agricultural, also this positive effect. Today, the exterior arid mornings and noons are difficult to handle even in the local most humid season. Different species relation and co-habitation that brings advantages to all involved is discussed i.e. by Non-antropocentric architecture as a subfield of Performance Oriented Design (Hensel 2013; Hensel 2015a). Keeping quite constant temperatures (Kempe 1988; Vegas et al. 2014) as also registered by this research, underground settlements might play key role in adaptation to weather extremes envisioned due to the climate change by many countries, i.e. discussed locations of Czechia, Turkey and Norway but also in i.e. Canada and others (Czech Republic Ministry of the Environment and Czech Hydrometeorological Institute 2015; Republic of Turkey Ministry of Environment and Urbanization 2012; Richardson 2010; Flæte et al. 2010).

It is difficult to evaluate the exact use, design and enclosures of observed settlements. Though some literature is available it contradicts with each other as well as with the information provided by locals or tourist information on site. This is not so surprising, knowing that the dwellings have been constantly redesigned for different purposes. At the moment, the largest amount of the caves is also disintegrating. The whole complexity of underground cities has not been yet discovered. It is also not certain how the climatic conditions changed since the times of first cave builders to recent times. This seems to justify contemporary research on transformative adaptive buildings that can rebuild themselves thanks to robotics or biology, or its combination such as famous pioneering project by R&Sie(n), New Territories (R&Sie(n) 2014; Roche 2010). The literature on mapped systemic relations is lacking, therefore it cannot be compared and definitely more extensive research has to be done for more detailed and complex conclusions. However, the general observations of subtractive and additive techniques in relation to ground motivate future research in this direction.

5 Conclusions:

The discussed Collaborative Collective's projects tend to manipulate climates through spatial distribution, ranging from exterior to interior carved into ground, and natural ventilation, such as roughly observed in Cappadocia by this initial study. There is much more to be investigated. The spaces should be 3d scanned and annual daily climatic and air circulation measures and other experience stimuli, such as acoustics and visual information recordings, should be performed in reference to material, its density, thickness, geomorphological and geological organization, and the last use of the spaces if available.

There is a lot of data in Ayhan's master thesis on geological and morphological investigations of the underground cities, but it is discussed in relation to contemporary existing settlements on place context (Ayhan 2004). An interesting technological socio-acoustics studies on hypogeum has been performed by Debertolis et.al. (Debertolis, Coimbra, and Eneix 2015; Debertolis, Gull, and Richeldi 2013), but mainly only in anthropological character. More natural sciences to humanities and tacit data and experiences have to be related. Futures for complex tools for this are researched in recently starting project "Curating the Emergence of Thrivability and Realizing Sustainable Futures in Socio-Ecological Systems" by Finidori (Finidori 2016). Such pre-studies as this one have both, importance and relevance when not enough complex research can be done, collecting, communicating and arguing relations of data with tacit knowledge trough images as well as generating tacit understanding of climate control through lived experience of the designer. Different principles of local specific vernacular architectures can enrich today's designs, however, it has to be adjusted to site specific settings, as proposed by Hensel and Turko (Hensel 2015b; Hensel and Turko 2015). Even though we might not really know how these spaces were really used, enclosed, built, rebuilt, and what were their exterior climatic settings over time, the data and its systemic relations of the situation such as it is can also well serve and be applied to contemporary design research in relation to today behavioural activities in ambient environment. Through the measures, it shows that the most important factor of the climatic conditions was ventilation stream passing through different layers of spaces, depth and height coming after that – all organized in co-existence to its use. It seems that symbiosis of humans and other species can play crucial role in climate comfort and both mentioned vary over time. Due to recent fast climate and society change, transformative adaptive architecture should be investigated with the use of biology: reconfiguration as a new form of recycling.

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