Urban Pandemic Digitalisation & Water Infrastructures

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WaterCentre@KTH

8 December 2021

Cities as Arenas of Innovation

Vallis, Unreinforced Masonry Precincts in New Zealand: History, Heritage, and Seismic Retrofit, PhD Thesis, University of Auckland, 2020.

Whanganui, New Zealand, 2017

CHANGE and ADAPTATION

Sydney, Australia (2020)

Contents

Exploring Digitalisation of Urban Sanitation

- **Motivations: Water and Cities**
- **Theoretical Background: HCI to HBI**
- **Evolving User Interactivity: Case Study: Emergence of Urban Sanitation and Monitoring**
- **Generating Speculative Urban Futures**

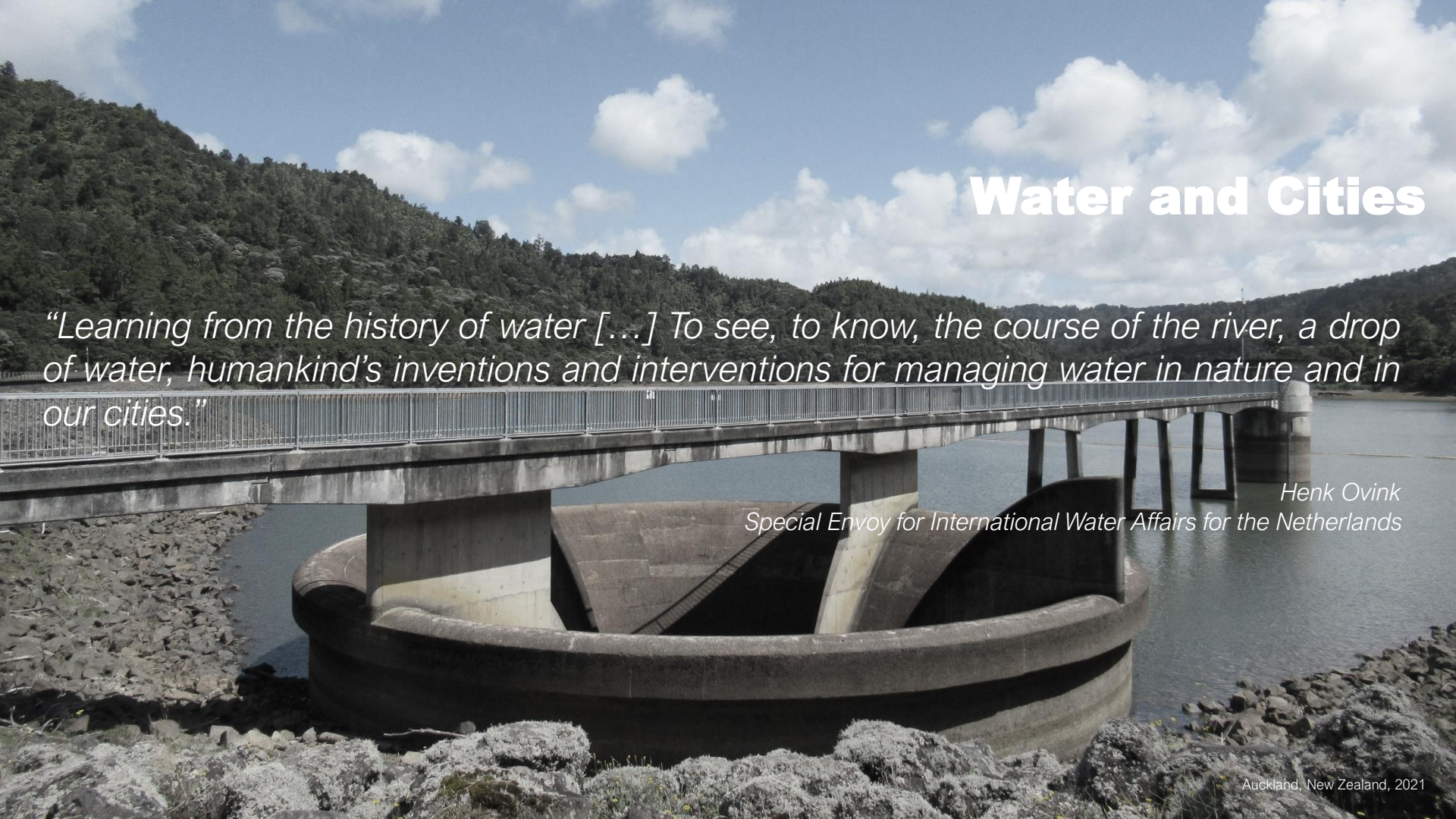
1. Theoretical Desktop Performance Mapping
2. Place-Based Expert Stakeholder/User Studies
3. Participatory Design Fiction Workshops

Research Motivations |
Water and Cities

Water and Cities

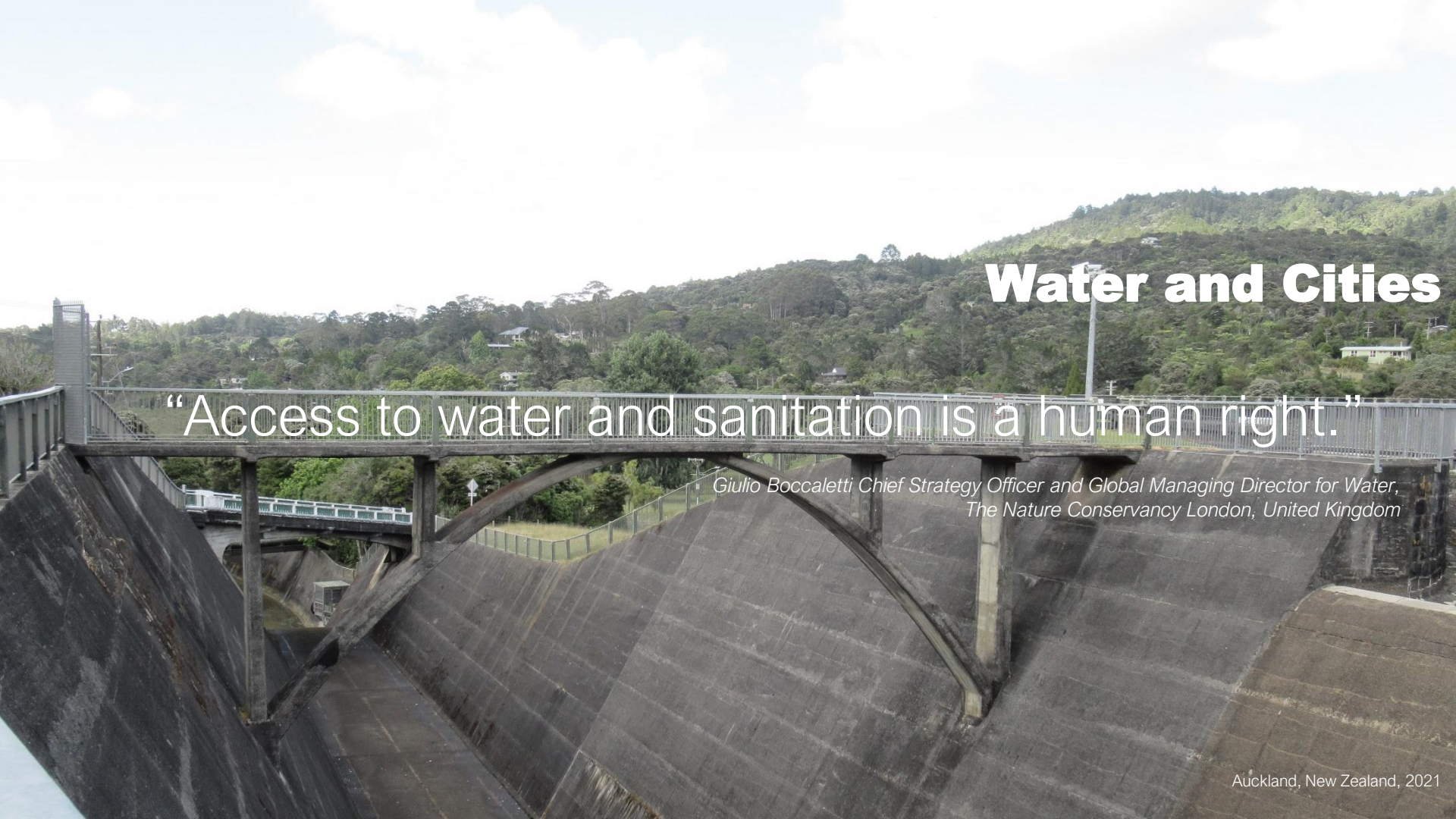
“Learning from the history of water […] To see, to know, the course of the river, a drop of water, humankind’s inventions and interventions for managing water in nature and in our cities.”

Henk Ovink
Special Envoy for International Water Affairs for the Netherlands



Auckland, New Zealand, 2021

Water and Cities



"Access to water and sanitation is a human right."

Giulio Boccaletti Chief Strategy Officer and Global Managing Director for Water, The Nature Conservancy London, United Kingdom

Auckland, New Zealand, 2021

Water and Cities

"how climate change can affect cultural heritage and how cultural heritage can contribute to climate solutions through **risk management, adaptation and resilience strategies, and mitigation**, *projecting from the past into the future."*

Valérie Masson-Delmotte Paleoclimatologist, co-chair of IPCC Working Group I (physical sciences) for the 6th IPCC Assessment cycle
Saclay, June 5, 2019

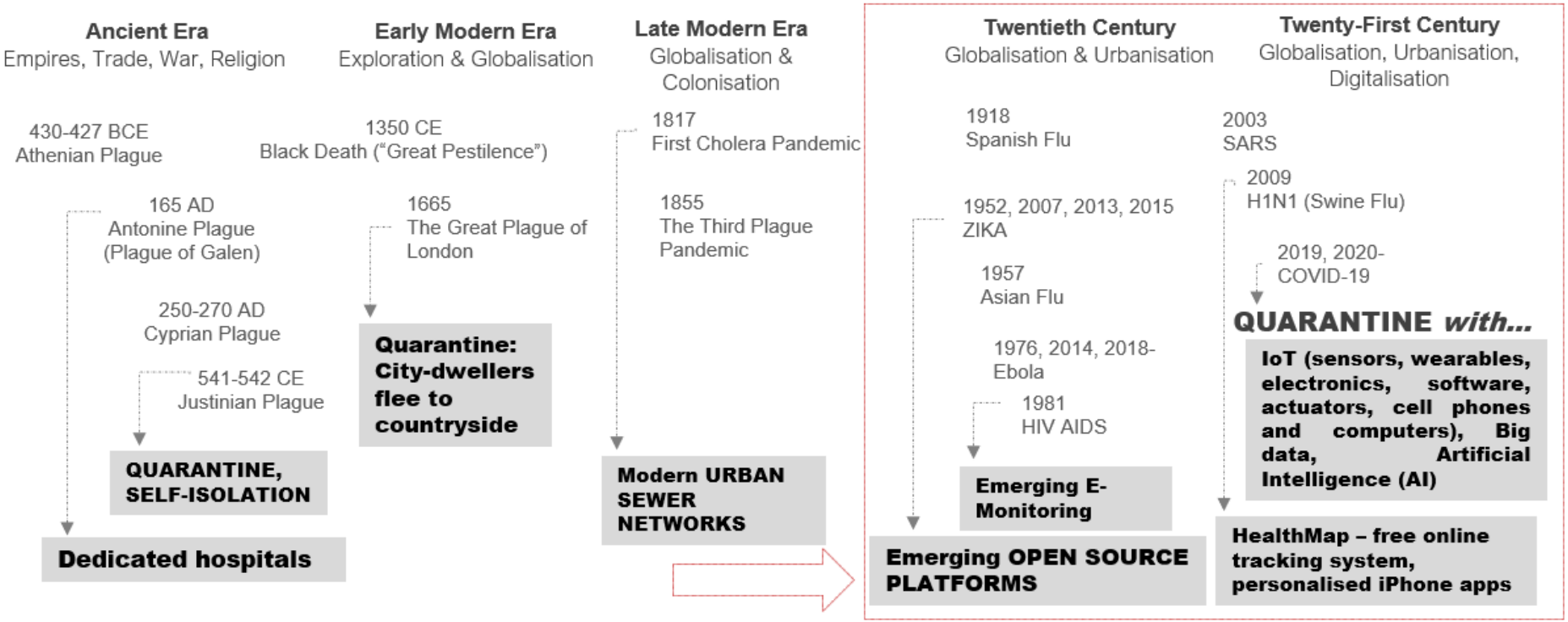
Auckland, New Zealand, 2021

Tracing Urban Pandemic Digitalisation |

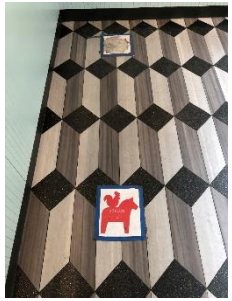
Evolving User Interactivity: Pandemic Urban Responses

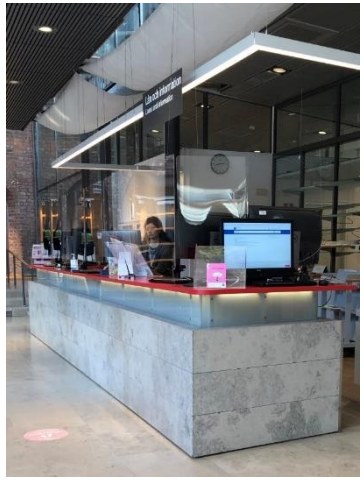
Pandemics Cities as Arenas of Innovation: A Timeline

Historic Institutional Responses to Pandemics



(Analogue) Urban Manifestations of COVID-19?





Stockholm, Sweden, 2021

Pandemic Access, Supply, Monitoring

SARS-CoV-2 wastewater data from cities across Sweden now available

Published: 2021-03-16

Waste water shows
Covid-19 in Stockholm region

Researchers sample sewage to measure infections in six European countries

“..securing water, sanitation, and hygiene (WASH) for all..”

Stockholm International Water Institute (SIWI), UNICEF

https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public

To what extent can the digitalisation of sanitation infrastructures shape future public user interactivity and the respective civic rights to privacy within urban settings?

Keywords: *Digitalisation; Human-Building Interaction; Urban Sanitation*

Intersection of...

Architecture (Built Environment) x Human-Computer Interaction (HCI)

Tracing Urban Pandemic Digitalisation | **Theoretical Background**

Theoretical Background

Human-Computer Interaction (HCI)

to

‘Human-Building Interaction (HBI)’

Alavi, H., Churchill, E., Wiberg, M., Lalanne, D., Dalsgaard, P., Schieck, A., and Rogers, Y. Introduction to human building interaction (HBI): Interfacing HCI with architecture and urban design. *ACM Trans. on Computer-Human Interaction 26*, 2 (2019), 6.

Ubiquitous Computing

Mobile Computing

Ambient Computing

Tracing TRANSDISCIPLINARY Origins

Pervasive Computing

Tangible Computing

Urban Computing

Embedded Digital Interactions..

Literary Contributions

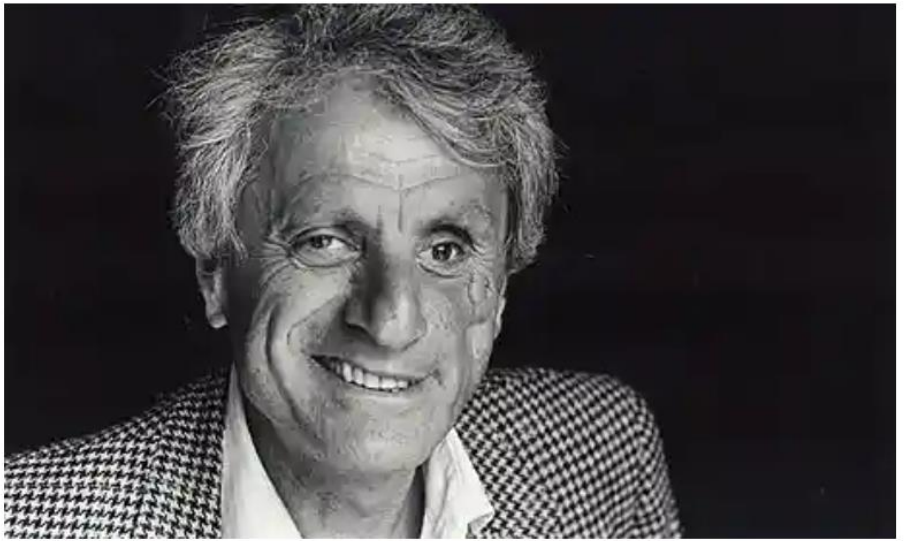
Iannis Xenakis, mid-1960s

Integration of digital elements within architectural and musical work:

Multimedia 'Philips Pavilion', Brussels World Fair 1958, designed with Le Corbusier

How Iannis Xenakis turned his back on architecture for classical music

Xenakis's collaboration with Le Corbusier on the Philips Pavilion was the catalyst for him becoming one of our most important composers



Composer, engineer and architect Iannis Xenakis. Photograph: Jane Bown

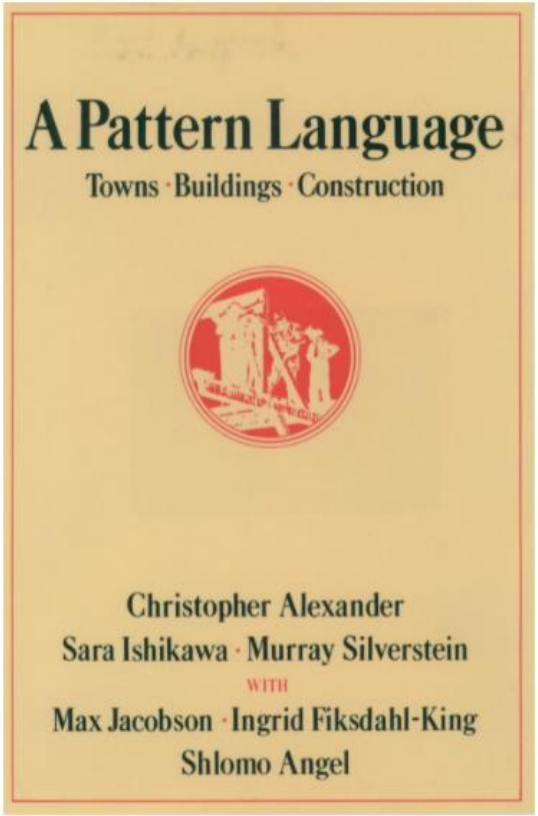
https://www.theguardian.com/music/tomserviceblog/2009/feb/18/iannis-xenakis-architecture-classical

Literary Contributions

A Pattern Language (1977) by Christopher Alexander, Sara Ishikawa, and Murray Silverstein

Predefined architectural forms
Intended for adaption to different geographic contexts

Influential for Design Decision-Making and Systems-Thinking, Computer Science



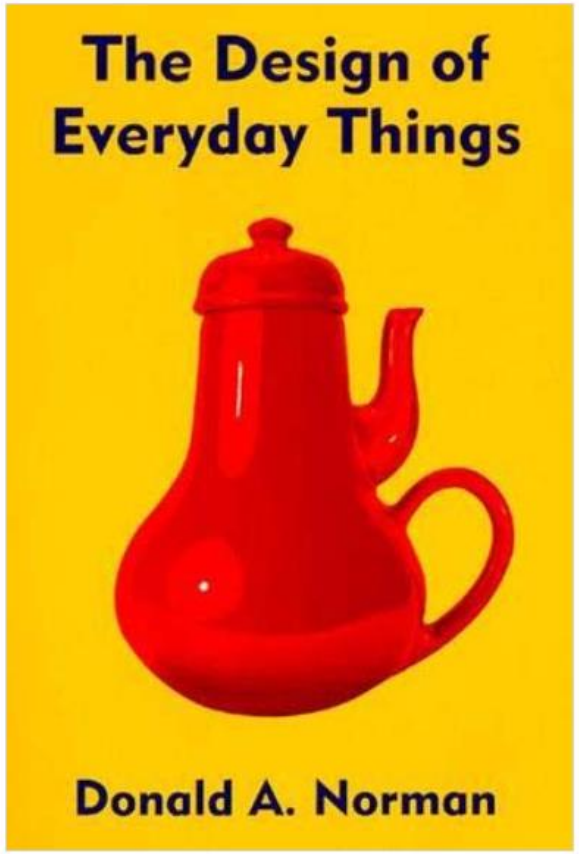
https://www.amazon.se/Pattern-Language-Towns-Buildings-Construction/dp/0195019199/ref=asc_df_0195019199/?tag=shpngadsglede-21&linkCode=df0&hvadid=476409100735&hvpos=&hvnetw=g&hvrand=22687787559120 5884&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9062465& hvtargid=pla-450641072071&psc=1

Literary Contributions

The Design of Everyday Things (1988) by Donald A. Norman

Existing architectural metaphors in Human-Computer Interaction (HCI)

Relationship between Object and User

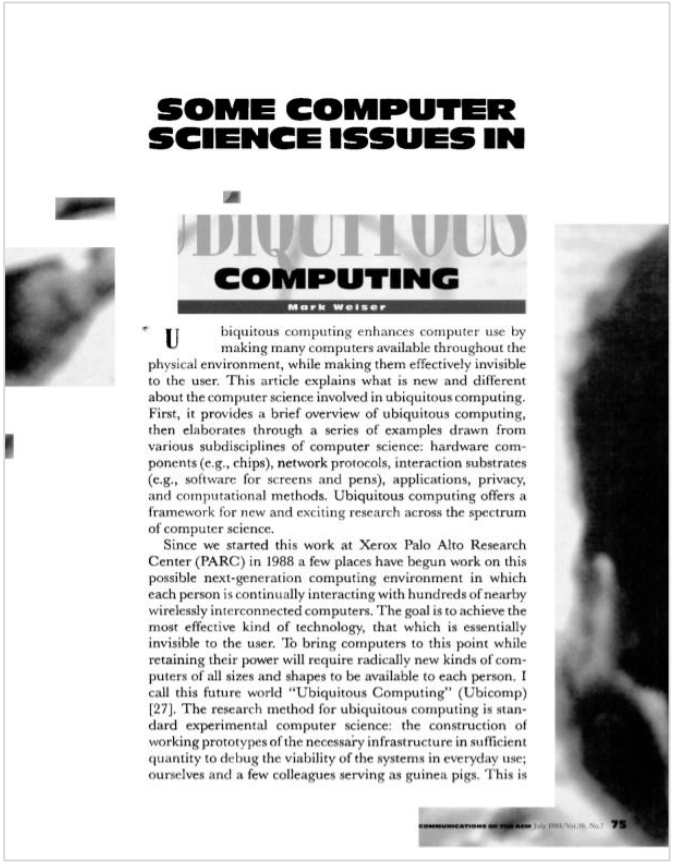


https://mitpress.mit.edu/books/design-everyday-things

Literary Contributions

Some computer science issues in ubiquitous computing (1993) by Marc Weiser

"ubiquitous computing enhances computer use by making many computers available throughout the physical environment, while making them effectively invisible to the user"



SOME COMPUTER SCIENCE ISSUES IN

UBIQUITOUS COMPUTING

Mark Weiser

Ubiquitous computing enhances computer use by making many computers available throughout the physical environment, while making them effectively invisible to the user. This article explains what is new and different about the computer science involved in ubiquitous computing. First, it provides a brief overview of ubiquitous computing, then elaborates through a series of examples drawn from various subdisciplines of computer science: hardware components (e.g., chips), network protocols, interaction substrates (e.g., software for screens and pens), applications, privacy, and computational methods. Ubiquitous computing offers a framework for new and exciting research across the spectrum of computer science.

Since we started this work at Xerox Palo Alto Research Center (PARC) in 1988 a few places have begun work on this possible next-generation computing environment in which each person is continually interacting with hundreds of nearby wirelessly interconnected computers. The goal is to achieve the most effective kind of technology, that which is essentially invisible to the user. To bring computers to this point while retaining their power will require radically new kinds of computers of all sizes and shapes to be available to each person. I call this future world "Ubiquitous Computing" (Ubicomp) [27]. The research method for ubiquitous computing is standard experimental computer science: the construction of working prototypes of the necessary infrastructure in sufficient quantity to debug the viability of the systems in everyday use; ourselves and a few colleagues serving as guinea pigs. This is

COMMUNICATIONS OF THE ACM July 1993/Vol.36, No.7 75

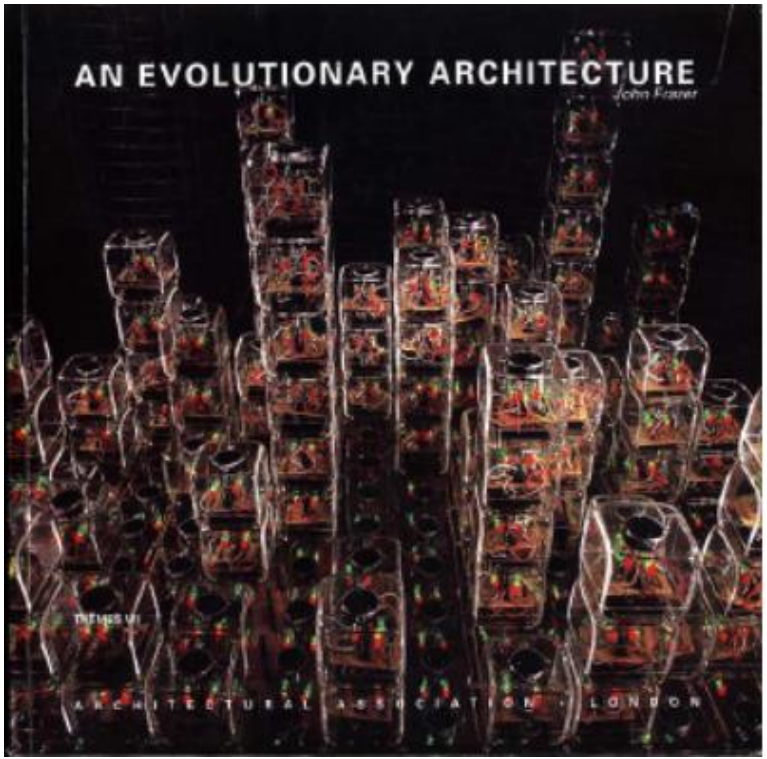
https://www.cs.princeton.edu/courses/archive/spring99/cs598c/papers/p75-weiser.pdf

Literary Contributions

An Evolutionary Architecture (1995) by John Frazer

Architectural computation x tangible interaction

Digital Inhabitation



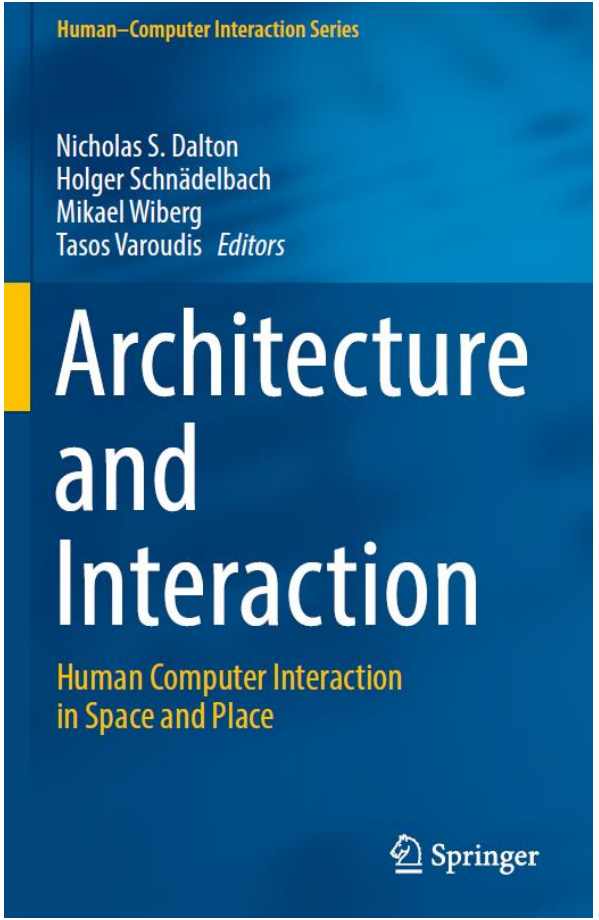
http://www.johnfrazer.com/author.html

Literary Contributions

Architecture and Interaction; Human-Computer Interaction in Space and Place (2016) ed. Nicholas S. Dalton, Holger Schnädelbach, Mikael Wiberg, Tasos Varoudis

"interactive architecture" – Responsive, Sensing

blurring architecture x art installation x new applications of digital technologies



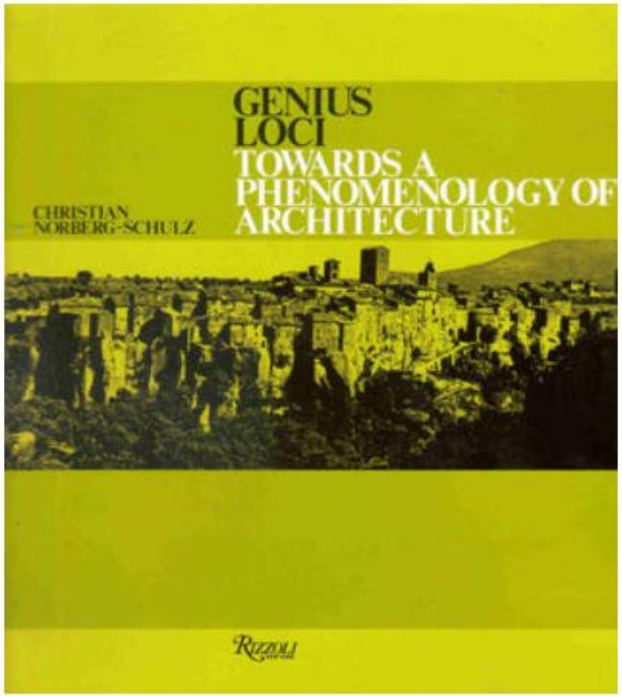
Literary Contributions

Through the Interface (1990) by Susanne Bødker

Genius loci: towards a phenomenology of architecture (1980) by Christian Norberg-Schulz

Material “texture” and “skin”

*Intersection of **architecture, material science**, and **interaction design***



https://www.goodreads.com/book/show/418524.Genius_Loci

Shifting interdisciplinary thinking:

from cyberspace as a separate reality to digital tectonics integrated within physical space

Many contemporary architectural contributors:
Peter Eisenmann, Greg Lynn, Patrick Schumacher…

Navigating the Transition: HCI → HBI

"relating to social context, specifically historical and cultural connections to enhance the wellbeing of the users"

Summary

Juxtaposing Analogue and Digital Urban Fabric

"The street of tomorrow takes the form of an information superhighway, while a teleport is in the agora"

Gzell in Jasiński, A.."Public space or safe space – remarks during the COVID-19 pandemic." *Technical Transactions* 117 (2020)

Summary

Scalar Considerations

Interactables →

Smart Architectonic Components →

Smart Cities

wellbeing

Embedded

Digital Tectonics

Design Decision-Making

Juxtaposing

Material "texture" and "skin"

Scalar

Responsive, Sensing

"invisible to the user"

Summary

- Theoretical shift between HCI and HBI
- Transdisciplinary exchanges between architectural and computer-science
- Social and spatial implications of responsive, sensing environments??

Summary

Core Principles

Changes in USE

PERSONAL Consent and PUBLIC Access

PERMANENCE

Impacts on User Interactivity

Reuse or New Uses

Provision of Private Data to gain access to Public Spaces

Long and Short Term Collection, Storage, Transfer of Personal Data

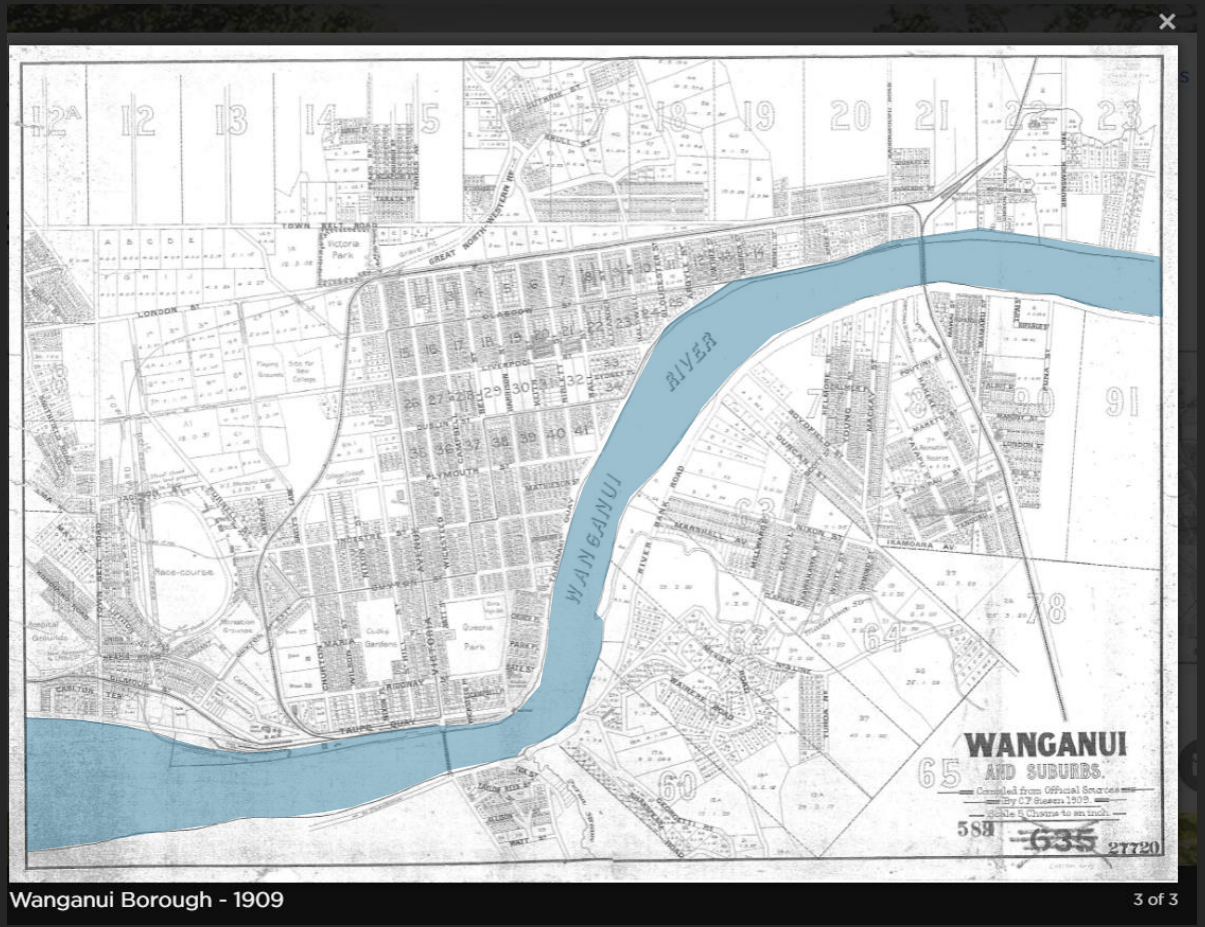
Mapping Sociospatial Implications

Tracing Urban Pandemic Digitalisation |

Case Study:
Emergence of Urban Sanitation and Monitoring

Historic architectural traditions of city building:

Characterized by public urban sanitation infrastructure undertakings in accordance with the needs of their populations



https://www.whanganui.govt.nz/Your-Council/About-Whanganui-District-Council/Whanganui-District-Council-Archives/Historic-rates-records-database/Maps

Tracing Historical Precedent through User Interactivity

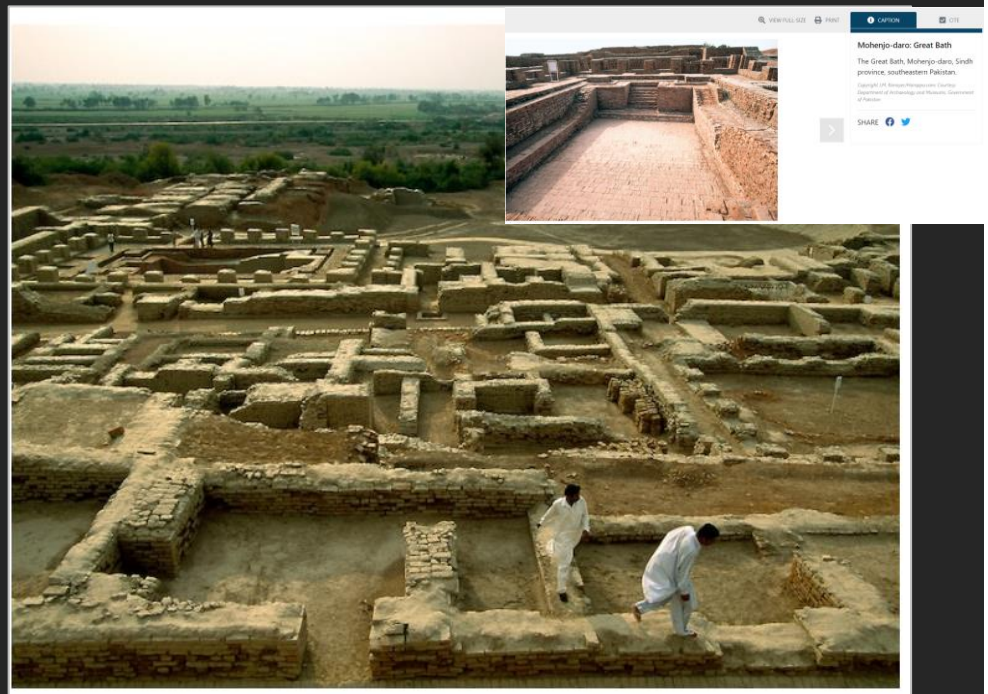
Core Principles	Impacts on User Interactivity
Changes in USE	*Extent of Reuse or New Use/s?*
PERSONAL Consent and PUBLIC Access	*Extent to which Personal Data is needed for Access to Public Spaces and Services?*
PERMANENCE	*Long/Short Term Changes to Urban Fabric, Uses, Experiences*

Historical Precedents |
Ancient Era

New, Permanent Infrastructures

Harappa and Mohenjo-Daro
Indus River Valley Civilization
Emerged c. 4,500 years ago

Among first urban sanitation systems (inc. domestic dwellings):
Urban street grid and intricate drainage system



The Indus Valley civilization was entirely unknown until 1921, when excavations in what would become Pakistan revealed the cities of Harappa and Mohenjo Daro (shown here). This mysterious culture emerged nearly 4,500 years ago and thrived for a thousand years, profiting from the highly fertile lands of the Indus River floodplain and trade with the civilizations of nearby Mesopotamia.

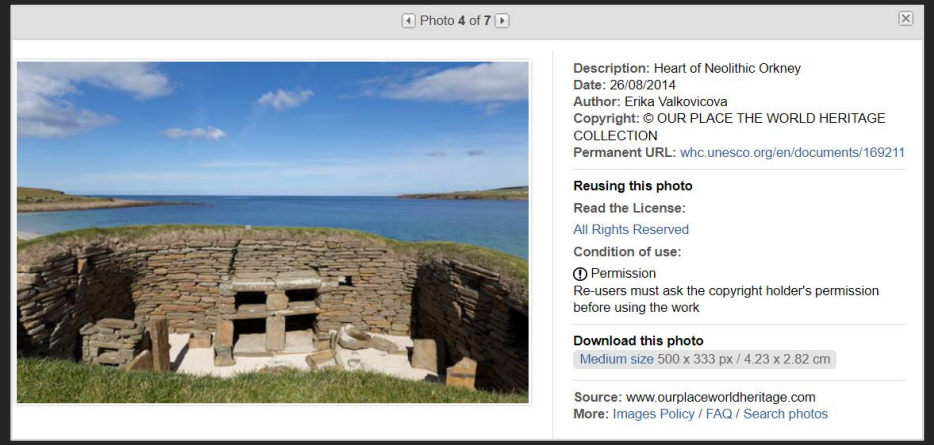
PHOTOGRAPH BY RANDY OLSON

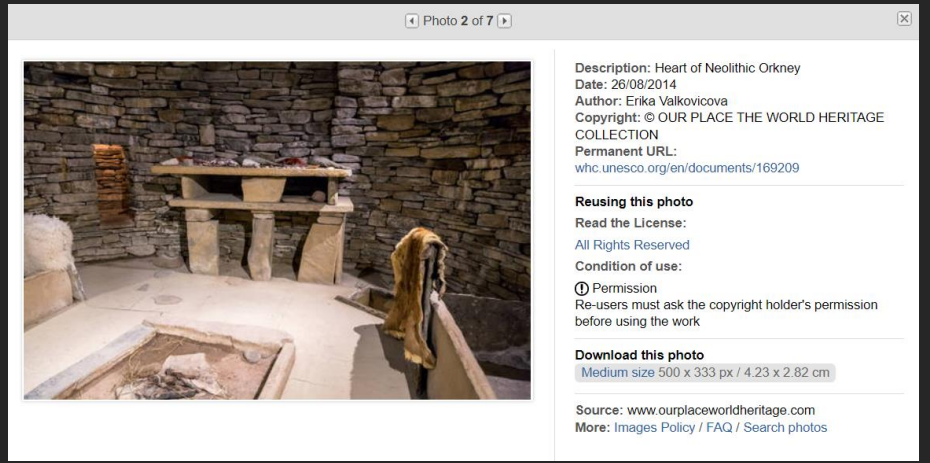
https://www.nationalgeographic.com/history/article/mohenjo-daro

New, Permanent Infrastructures

Skara Brae, Orkney Islands, Scotland
c.3100-2500 BCE

Among first sanitation systems (inc. domestic dwellings): believed to contain public drains and indoor toilet (recesses)





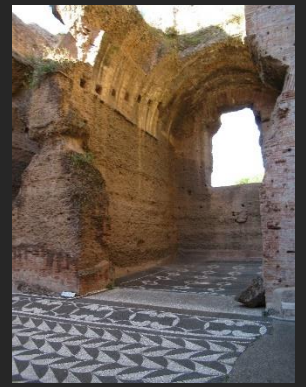
https://whc.unesco.org/en/list/514/gallery/
https://www.worldhistory.org/Skara_Brae/

New, Permanent Infrastructures

Roman Empire
c. 2nd Century BCE

Aqueducts: Public Baths + Communal Latrines

https://theconversation.com/talking-heads-what-toilets-and-sewers-tell-us-about-ancient-roman-sanitation-50045



Pompeii (left and centre, above), and Rome (right, above) Italy, 2018

Historical Precedents |
Early and Late Modern Eras
Europe and North America

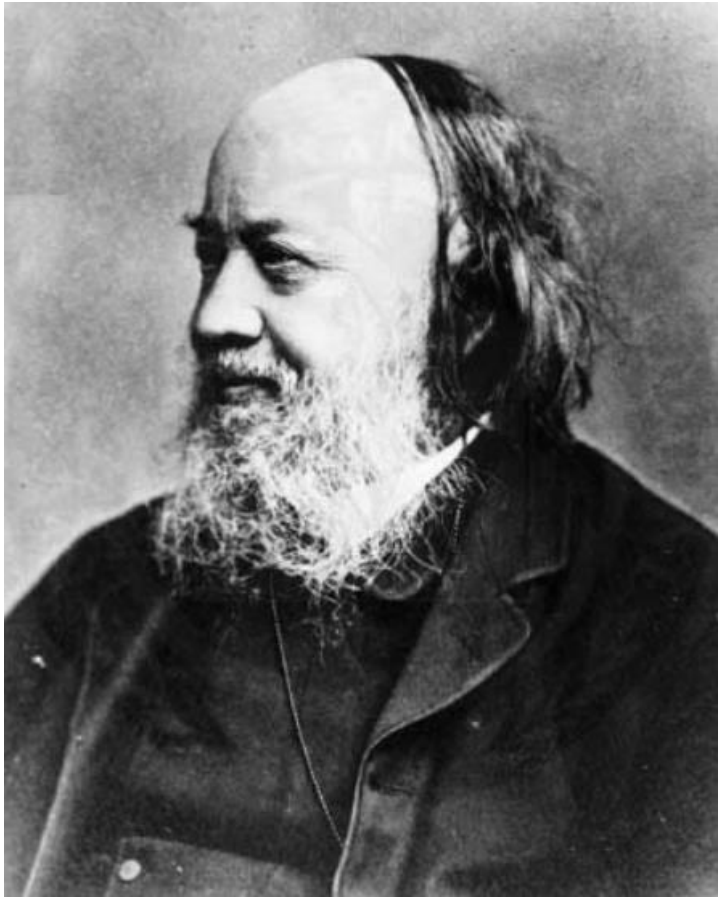
New Urban Infrastructures

Edwin Chadwick, England

The “Sanitary Idea”:

“…the physical environment exercised a profound influence over the wellbeing of the individual”

→ Clean Water Supply + Removal of Sewage + Disposal of Refuse



https://www.britannica.com/biography/Edwin-Chadwick#/media/1/104227/136533

New, Permanent Urban Infrastructures

Edwin Chadwick, England

1834–46 Reform of the Poor Laws

1842 *Report on the Sanitary Condition of the Labouring Population of Great Britain* (1842)

1848 Public Health Act

→ Integrated Sanitary Systems?
Inc. Demand = Water-Carriage Systems,
Washing/Bathing/Water Closets, Slow-Sand Filters

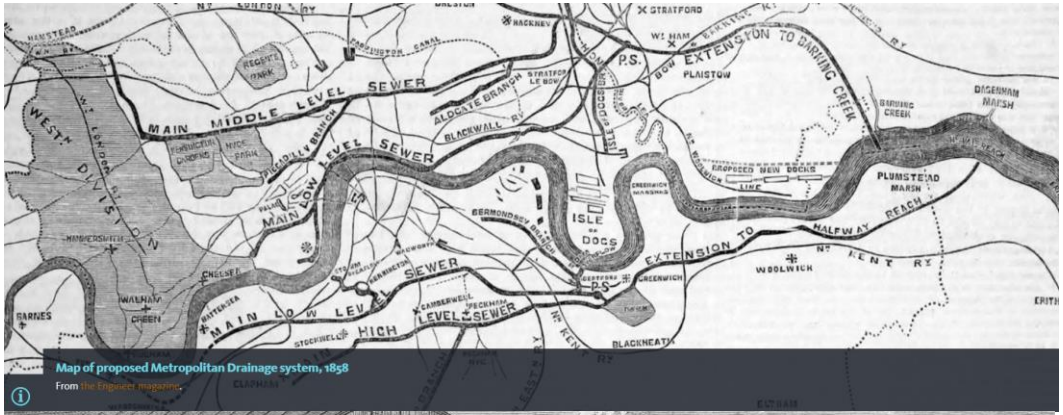
New, Permanent Urban Infrastructures

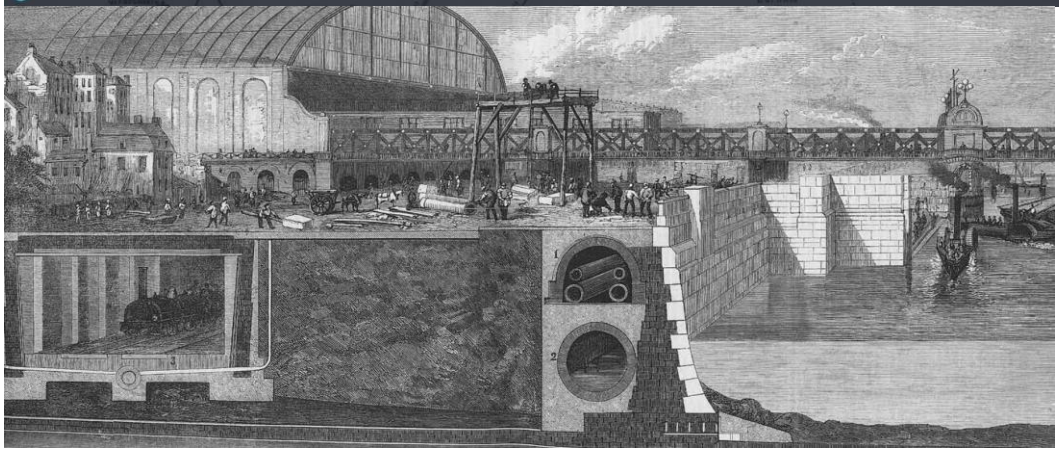
England

Sir Joseph Bazalgette:

Design of London's sewer network

Underground network connecting individual municipal drains





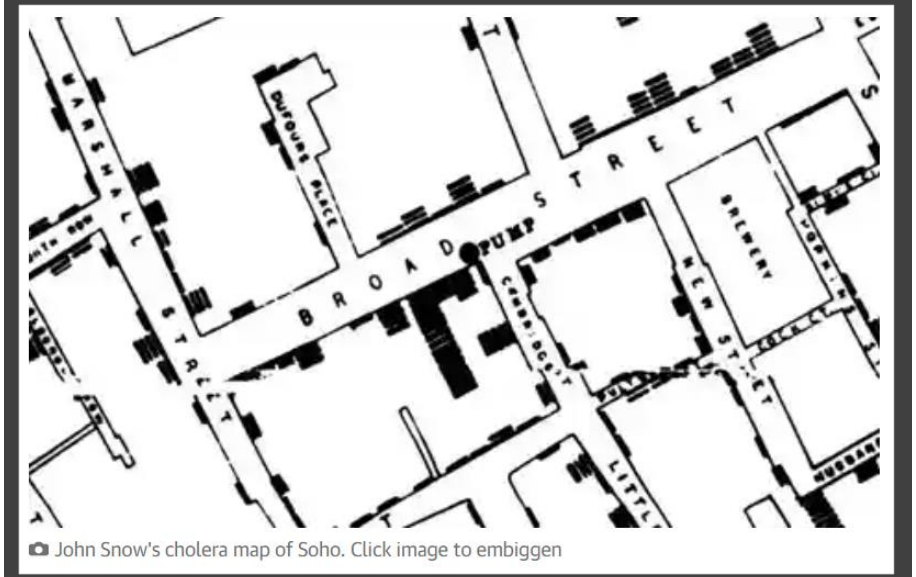
https://www.museumoflondon.org.uk/discover/how-bazalgette-built-londons-first-super-sewer

New, Permanent Urban Infrastructures

England

The Broad Street Pump
Dr. John Snow

"On the Mode of Communication of Cholera" (1849)



John Snow's cholera map of Soho. Click image to embiggen

https://www.theguardian.com/news/datablog/2013/mar/15/john-snow-cholera-map
https://www.immunology.org/john-snows-pump-1854

New Urban Infrastructures

Industrialization x Urban Development

"Age of Miasmas"
Environmental Sanitation

vs

Bacteriological Theory ("Germ Theory")

"Sanitation and good hygiene practices such as washing walls and floors, removing the foul-smelling sources of miasmas—decaying waste and sewage—were miasmatic measures.

Contagionist measures were those such as quarantine and restriction of movement, preventing direct contact with potentially infected people....In practice, both types of measures were used."

https://www.sciencemuseum.org.uk/objects-and-stories/medicine/cholera-victorian-london

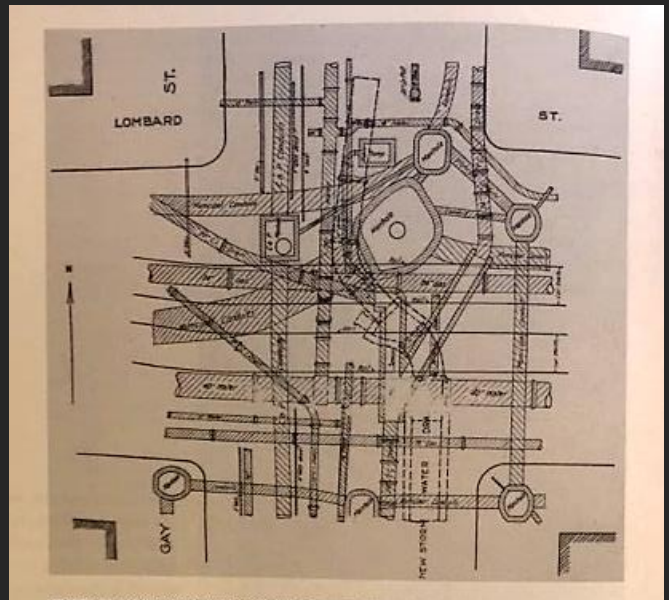
New, Permanent Urban Infrastructures

Industrialization x Urban Development

Sanitary services conceived "as part of the technologically networked city"

19thC & early 20thC Europe and U.S.

Civic Roles: Citywide Waterworks



UNDERGROUND PIPES AND CONDUITS AT GAY AND LOMBARD STREETS IN BALTIMORE IN 1908. Increasingly, the development of new technologies of sanitation contribute to what Lewis Mumford called "the Invisible City."

Martin V. Melosi, *The Sanitary City; Urban Infrastructure in America from Colonial Times to the Present*, The John Hopkins University Press, 2000

"Invisible City"?

New, Permanent Urban Infrastructures

Water Supply + Wastewater:
20thC, Latter 20thC

Challenges:
Inadequacies in the
"technologies of sanitation"

Water Tower

101 Doon Street, Invercargill

Water Tower. Image courtesy of www.flickr.com.
Copyright: Shellie Evans - flyingkiwigirl. Taken By: Shellie Evans - flyingkiwigirl. Date: 1/01/2014.

List Entry Information

List Entry Status
Listed

List Number
394

List Entry Type
Historic Place Category 1

Date Entered
22nd November 1984

Public Access
Private/No Public Access

Date of Effect
22nd November 1984

https://www.heritage.org.nz/the-list/details/394

Permanence AND Resilience?

Current Precedents |
The Contemporary Era

New Uses of Existing Infrastructures

21st Century:
Wastewater-Based Epidemiology (WBE)

Monitor the presence of Covid-19 through fecal-oral transmission in urban populations

Testing wastewater to detect waves of COVID-19 infections

SHARE: FACEBOOK LINKEDIN TWITTER EMAIL

Henriksdal wastewater treatment plant. Photographer: Kari Kohvakka/Stockholm Vatten och Avfall.

Pandemic outbreaks can come in several waves, as occurred with the Hong Kong flu of 1968 and the so-called swine flu in 2009. Now, a group of scientists, among them researchers from KTH and SciLifeLab, will keep track of the COVID-19 developments by testing wastewater.

https://www.scilifelab.se/news/testing-wastewater-to-detect-waves-of-covid-19-infections/

New Uses of Existing Infrastructures

21st Century: Wastewater-Based Epidemiology (WBE)

"The idea is to collect wastewater from several wastewater treatment plants, filter the contents and extract the genetic material [...]

Since the genetic material is derived from hundreds of thousands of individuals, the method provides a cheap way of monitoring the overall load of the virus in the population."

Stockholm, 2021

Sociospatial Implications?

How are existing, physical (analogue) urban wastewater infrastructures used for monitoring the spread of the COVID-19 pandemic?

To what extent is digitalisation currently used, or can enhance public wellbeing through urban sanitation?

Tracing Urban Pandemic Digitalisation |

Generating Speculative Urban Futures

“**spatiotemporally immersive** urban scenarios and spaces”

“Interactional Choices?”

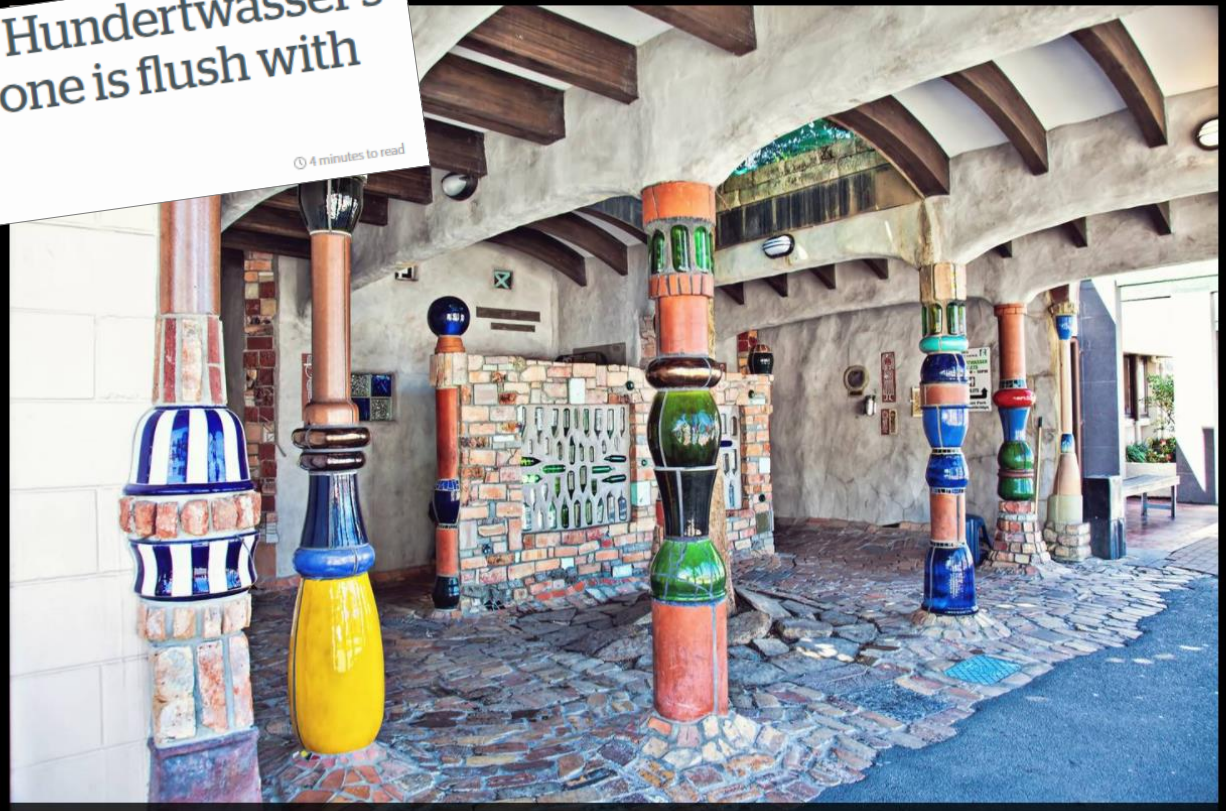
Secure, Equitable Provision and Access of Public Toilet Infrastructures/Services:

Private acts within Public Settings?

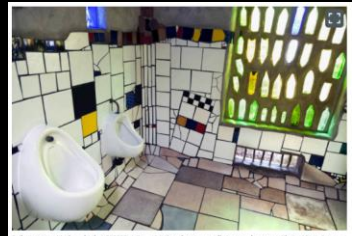
Toilet tourism: Hundertwasser's Kawakawa throne is flush with visitors

4 Feb, 2019 01:00 AM

4 minutes to read



Hundertwasser Town: Kawakawa has become famous for the toilets' unique design. Photo / Getty Images



https://www.nzherald.co.nz/travel/toilet-tourism-hundertwassers-kawakawa-throne-is-flush-with-visitors/MF24JIBGHCV54E3MY3BTSQZBQI/

Public Washroom as physical-digital (hybrid) architectural interface?

Inside the toilet that attracts hundreds of thousands of tourists. Photo / Instagram

https://www.nzherald.co.nz/travel/new-zealands-top-drop-the-kiwi-public-toilet-that-lures-in-thousands-of-tourists/LZOWAQCFZUNUFPDPWBX6FGEDWU/

Research Phase II:
Expert Stakeholder Perspectives/User Studies – Interviews, Site Observations

- Changes in USES of urban sanitary facilities (i.e. public washrooms)?
- How have populations kept safe and how have they retained their urban liberties to use these spaces?
- Have digital technologies aided this experience?
- How can digital technologies support transitions to less restricted urban futures?

Stockholm, Sweden, 2021

Research Phase III: Participatory Workshops

Participatory Design-Fiction Methodology

Generating Alternative, Urban Scenarios

"…scenarios, user observation, brainstorming, rapid prototyping, critical design, speculative design"
Sterling, 2009

HCI x Architectural Design Philosophies?

Enhancing
Interactional Choices
for all Users

Changes in USE?

PERSONAL Consent and PUBLIC Access?

PERMANENCE?

Tracing Urban Pandemic Digitalisation | **Summary**

Summary

- Closely bound histories of urban water management and city-building
- Tracing traditions of urban sanitation reveal transitions between physical, built → physical-digital hybrid urban fabric
- Human-Building Interaction (HBI) theory informs a shared platform for: Architecture x Interaction
- Case Study: COVID-19 pandemic to examine opportunities for alternative, digitalized urban scenarios that enhance wellbeing

Thank-You! | Tack!