EXPLORING THE BARRIERS TO STREAM DAYLIGHTING: THE CASE OF ANKARA

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ABSTRACT

EXPLORING THE BARRIERS TO STREAM DAYLIGHTING: THE CASE OF ANKARA

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Globally, stream daylighting is recognized as a prominent urban planning strategy to make cities prepared for in the face of climate change. In Ankara, Türkiye, historical urbanization and water management practices have led to the burial of natural streams, leading to significant challenges such as increased flooding exacerbated by climate change, pollution, and ecological degradation. Despite the urgency of these issues, actions to address the consequences of stream burial in the city remain limited.

This study investigates the challenges to implementing stream daylighting in Ankara, systematically analyzing diverse perspectives to reflect the multifaceted nature of the issue. Using primarily qualitative research methods, it adopts a combined analytical framework integrating content and thematic analysis. The research begins with a global review of stream daylighting strategies, categorizing findings into three themes: (i) drivers, (ii) challenges, and (iii) actions derived from project-based case studies. Subsequently, semi-structured, in-depth interviews were conducted with stakeholders, including representatives from public authorities, non-governmental

organizations, and academic institutions, to explore how the challenges observed in the case of Ankara align with or differ from those identified in the literature.

The results classify the challenges to stream daylighting in Ankara, revealing challenges such as project mismanagement, financial constraints, institutional limitations, and local-specific factors like geological risks, jurisdictional overlaps, and public resistance. The study underscores the importance of multidisciplinary planning, effective governance, and sustainable design approaches tailored to Ankara's unique ecosystem. It offers actionable recommendations for stream daylighting, contributing to both mitigating the adverse impacts of climate change and enhancing urban adaptation strategies.

Keywords: Stream Daylighting, Ankara, Climate Change, Urban Planning

ÖZ

DERELERİN GÜNYÜZÜNE ÇIKARILMASI ÖNÜNDEKİ ZORLUKLAR: ANKARA ÖRNEĞİ

Ersözlü, Ekin
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Dünyada, *derelerin gün yüzüne çıkarılması* iklim değişikliği karşısında dirençliliği artırmak amacıyla öne çıkan bir kentsel planlama stratejisi olarak öne çıkmaktadır. Ankara, Türkiye'de ise süregelen kentleşme ve su yönetimi uygulamaları, doğal akarsuların yer altına gömülmesine yol açmakta, bu da iklim değişikliğiyle birlikte artan sel olayları, kirlilik ve ekolojik bozulma gibi çeşitli problemlere neden olmaktadır. Konunun aciliyetine rağmen, Ankara'da derelerin yer altına alınmasının doğurduğu sorunlara yönelik alınan önlemler sınırlı kalmaktadır.

Bu çalışma, Ankara'da derelerin gün yüzüne çıkarılmasının önündeki engelleri ortaya çıkarmayı amaçlamaktadır. Araştırmada ağırlıklı olarak nitel araştırma yöntemleri kullanılarak, içerik ve tematik analizleri entegre eden birleşik bir analiz çerçevesi benimsenmiştir. Araştırmada, öncelikle, küresel düzlemde derelerin gün yüzüne çıkarılmasındaki (i) itici güçler, (ii) zorluklar ve (iii) uygulamadaki eylemler derlenmiştir. Ardından, kamu kurumları, sivil toplum kuruluşları ve akademisyenlerle yapılan yarı yapılandırılmış derinlemesine görüşmelerle,

Ankara’daki zorlukların literatürdeki bulgularla nasıl örtüştüğü veya farklılaştığı ortaya konmuştur.

Sonuçlar, Ankara’da derelerin gün yüzüne çıkarılmasının önündeki engellerini sınıflandırarak, proje yönetimindeki eksiklikler, finansal kısıtlamalar, kurumsal sınırlılıklar gibi zorlukların yanı sıra, jeolojik riskler, yetki alanı karmaşası ve toplumsal direnç gibi yerele özgü faktörleri de ortaya çıkarmaktadır. Çalışma, çok disiplinli planlamanın, etkili yönetişimin ve Ankara’nın özgün ekosistemine göre uyarlanmış sürdürülebilir tasarım yaklaşımlarının önemini vurgulamaktadır. Ayrıca, derelerin gün yüzüne çıkarılmasında uygulanabilir eylem önerileri sunarak, iklim değişikliğiyle mücadele ve iklim değişikliğinin etkilerine uyum stratejilerinin geliştirilmesine katkıda bulunmaktadır.

Anahtar Kelimeler: Derelerin Gün Yüzüne Çıkarılması, Ankara, İklim Değişikliği, Kentsel Planlama

To the bright future and those who strive to build it…

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CHAPTER 1

INTRODUCTION

1.1 Problem Statement

Stream burial in cities has led to significant changes in land use and the natural landscape, contributing to what is commonly referred to as "Urban Stream Syndrome." This phenomenon relates to the ecological degradation of natural streams caused by urban development (Walsh et al., 2005). The extreme diversity of environmental and social factors affecting urban flow globally results in significant variations in the manifestation of urban stream syndrome (Booth et al., 2016). Among the various ways of modifying streams, stream burial—where streams are piped, culverted, or paved over—is considered one of the most destructive methods, disrupts the natural landscape by directing streams into underground pipes (Elmore & Kaushal, 2008; Forgrave, 2022).

Over the past 50 years, water management has gained global significance, with Türkiye actively engaging in discussions to implement a basin-based, integrated approach. However, rapid urbanization, fragmented policies, legal ambiguities, and a lack of cross-sectoral coordination have hindered sustainable water management, leading to ecological degradation and inefficient stream rehabilitation (‘dere ıslahı’) practices. This led to inadequate integration of water-sensitive urban planning into spatial planning frameworks (Avcı, 2021; Kocabaş, 2024; Bahçeci, 2014).

Although various master plans through the history of Ankara prioritized preservation of natural valley systems, economic interests have often overridden environmental concerns, leaving Ankara’s urban center with diminished water surfaces and inadequate stormwater management. (Görmüş et al.,2023; ASKİ,2009; İdali,2020)

Consequently, Ankara's historical and ongoing burial and alteration of streams have severely damaged its ecosystem. Contemporary facing with increased flood risks, water pollution, and urban heat island effects exacerbated by climate change and rapid urbanization (ABB,2022; Atıcı & Ahiska, 2005; Oruc et al., 2022; Köse & Şahin, 2024)

Ankara provides a clear example of the urban stream syndrome and stream burial, where the once prominent rivers and streams have gradually faded from view but continue to shape the city's environmental and urban narrative.

Globally, many cities underwent extensive stream burial process during the 20th century. Practiced worldwide, streams have disappeared from urban surfaces due to infrastructure interventions of culverting small streams, then close them and transform them into a sewer line. However, as Buchholz et al. (2016) justify, the alarming levels of ecological events such as depletion of natural resources becoming evident in the 21st century highlighted the cruciality of sustainability, it has become clear that engineering and infrastructure solutions that serve economic interests are not profitable in the long term, and ecologically focused engineering and design solutions have begun to be applied to cities with the landscape infrastructure approach. To tackle this multifaced and complex problems should be tackled with reopening streams that were turned into canals and covered by being turned into a sewer line within the city that has been implemented in various metropolises around the world called ‘stream daylighting’’ (Buchholz et al. ,2016).

‘Stream Daylighting’, refers to the process of exposing buried streams and reintegrating them into urban landscapes has gained prominence as a -based solution for climate adaptation and mitigation. Stream daylighting emerges as promising strategy for addressing climate change impacts in urban areas and is a tool of green infrastructure having various benefits such as environmental, economic, social and psychological (Buchholz et al. ,2016). In addition to that there is diverse literature on stream daylighting proving the use of stream daylighting as an effective way to mitigate climate change in ways such as stormwater management, urban

cooling, and greenhouse gas reduction, while also enhancing socio-ecological resilience (Khirfan et al., 2020a).

However, implementing these types of solutions might be challenging. Moss (2000) has discussed the difficulty of changing the values of urban water infrastructural management of a city. The urban water infrastructural management of a city is shaped by the interplaying forces embedded in generations of social, institutional, economic, and political decision-making systems which have been ingrained through long-standing practices and established patterns over many years.

The "Urban Stream Syndrome" in Ankara may gradually worsen with climate change, potentially giving rise to a range of political, social, economic, and environmental problems. The research done by Çobanyılmaz and Duman (2013) describes Ankara as already “highly vulnerable” in terms of its social, economic, environmental, institutional and spatial structure.

Previous research (e.g., İdali, 2020; Çetiner & Şahin, 2020; Görmüş et al., 2023) has pinpointed potential areas in Ankara where streams could feasibly be reopened and daylighted. Additionally, it has highlighted the ecological potential for the recovery of the Ankara River and the possibilities for ecological networking within the Ankara valleys, serving as a guide for green infrastructure. However, there is a lack of research on the barriers to turning daylighting into action through real implementation projects, at least in certain parts of the city.

Consequently, there is a need for decisive interventions, such as stream daylighting in water management of Ankara, to effectively address these pressing conditions. As this is a more complex, multi-layered, and political problem, this study is designed to invite the participants and readers to think backward, to understand the essence of the problems through their current extensive knowledge and focus on the solutions rather than fixed on accumulated complexity, negativity and fear. The problems of applying nature-based solutions may require in-depth detailed understanding of a socio-environmental background of the study region. The ultimate aim of this study

is to explore the barriers to establishing stream daylighting involving related stakeholders and experts in the context of Ankara.

1.2 Aim of the Study and Research Questions

The ultimate aim of this research is to explore the barriers to implementing stream daylighting in Ankara in response to climate change. It adopts an exploratory approach to understand the underlying challenges of turning daylighting into action, in collaboration with representatives from local authorities, NGOs, and academia. In line with this, the study poses the following main research question (MRQ), followed by three sub-questions (Sub RQs).

MRQ: What are the challenges to establishing the practice of stream daylighting in Ankara in the face of climate change?

The research focuses on identifying various challenges to the stream daylighting in the local context of Ankara, considering changing climatic conditions. By analyzing these challenges, the study aims to provide insights into overcoming obstacles and promoting sustainable water management practices. To address the main question, the study comprises three interconnected sub-questions.

Sub RQ1: What are the contemporary global drivers, challenges and actions in stream daylighting applications?

RQ1 consists of the aim of reviewing stream daylighting literature and the global case studies in connection with the sub RQ2 and RQ3. The main function of the first sub-RQ is leading the base research for the field survey and discovering sufficient information about the background of the main research question.

Sub RQ2: How do the representatives of local authorities, NGOs, and academia perceive the challenges to stream daylighting in Ankara?

The second RQ2 aims to capture the perspective of the relevant actors on the challenges of stream daylighting and categorize them in a valid way.

Sub RQ3: What strategies can experts and relevant stakeholders employ to address identified challenges?

The third research question focusses on the current knowledge, perspective and priority of actions to stream daylighting in Ankara and strategies in response to the challenges addressed in RQ2.

1.3 Structure of the Study

This study mainly explores the challenges and actions related to stream daylighting in Ankara within the broader context of urban planning and climate change adaptation. The study is constructure over six main chapters (see Figure 1.1).

Chapter 1, the introduction chapter, explains how this study was conceived, outlining the background in focus to the Ankara case, motivation, and significance of the research. It introduces the key themes of stream daylighting and climate change adaptation, situating the study within the broader context of urban planning and environmental resilience. The chapter also presents the research objectives and questions that guide the investigation.

Chapter 2 provides a detailed account of the research methodology employed in the study. It explains the exploratory approach, data collection methods, and analytical frameworks used to examine the barriers to stream daylighting in Ankara. The chapter also discusses the involvement of key stakeholders—such as local authorities, NGOs, and academics—and outlines the steps taken to ensure the rigor and reliability of the research findings.

Chapter 3, the literature review, introduces background information and terminology related to water management, stream burial, and stream daylighting practices. It also

presents a stream daylighting case study document review and content analysis of 19 stream daylighting case studies. In this chapter, I explain each content about its case study. This chapter helps to understand the motivation and the actions taken behind the stream daylighting projects.

Chapter 4 focuses on the research findings that evaluated Ankara's case in terms of stream daylighting challenges and actions. This chapter narratively explains the perspectives of the experts and stakeholders revealing a rich background to the local context of barriers and strategies.

In the following Chapter 5, the research results were reviewed and synthesized comparing the literature review and interview results. The synthesis reveals the overlaps with the existing literature, gaps found, and the unique aspects of the Ankara case study.

The conclusion part discusses and summarizes the overall findings of the study. It also includes suggestions and closing remarks.

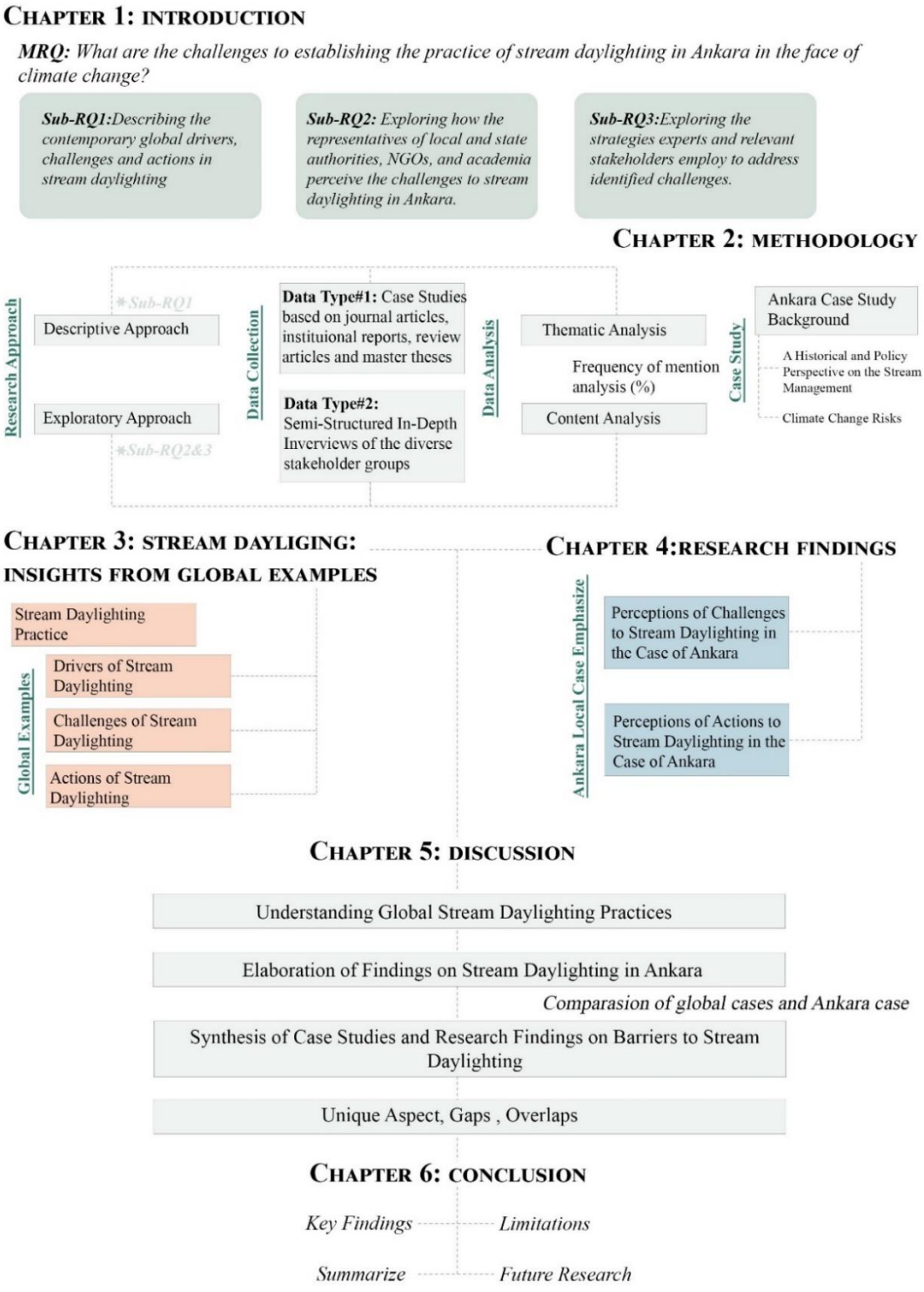

Figure 1.1 Thesis Flow Chart

(Source: Produced by the author)

CHAPTER 2

METHODOLOGY

This chapter begins by detailing the research design, outlining the methodological steps and the approach adopted to address each research question. It then elaborates on the data collection process, describing the methods employed, the sources of data, and their relevance to the study. Following this, the chapter systematically discusses the procedures and techniques used for data analysis. Finally, it concludes by illustrating how the analyzed data was interpreted to derive meaningful insights and fulfil the study's objectives.

2.1 Research Design

This research aims to answer the main research question: ’What are the challenges to establishing the practice of stream daylighting in Ankara in the face of climate change?’’

To achieve this, it poses three sub-research questions, as outlined in Table 2.1.

The research design of the study consists of research approaches as well as the methods and techniques for data collection and data analysis. The research approach outlines the context and rationale for its selection. According to Neuman (2012) there are three dominant social research purposes, describing a social topic, explaining a phenomenon or exploring a new topic. This study adopts two main approaches aligned with the nature of its research questions.

Table 2.1 Research Design

Sub-Research Questions			**Data Collection**	**Data Analysis**
1	*What are the contemporary global drivers, challenges and actions in stream daylighting applications?*	Descriptive	Document Review	Thematical Analysis
2	*How do the representatives of local authorities, NGOs, and academia perceive the challenges to stream daylighting?*	Exploratory	Semi-structured In-Depth Interviews	Content Analysis
3	*What strategies can experts and relevant stakeholders employ to address identified challenges?*	Exploratory	Semi-structured In-Depth Interviews	Content Analysis

The first sub-research question is addressed with a **descriptive research approach**. Descriptive research aims for addressing ‘describing" a phenomenon in detail. Based on a causal process explanation, this approach usually reports the background of the current data and creates a classification to describe the data (Neuman,2012).

The second and third sub-research questions are addressed with **exploratory approach**. The exploratory research approach, usually addressed for the new issues, that has not been discovered before. It aims to explore a new study area, helping for the future researches. This approach often directs the questions "What?" and “How?”, exploring extensive diverse sources to conduct the research without previously known or defined steps. The exploratory research approach examines the feasibility of research conjectures or formulate new research ideas (Neuman, 2012).

2.2 Data Collection

2.2.1 Document Review

Stream daylighting projects are developed in response to the unique urban qualities of each location, which often presents specific barriers. To explore these barriers, I selected case studies that include three fundamental topics presented in Figure 2.1.

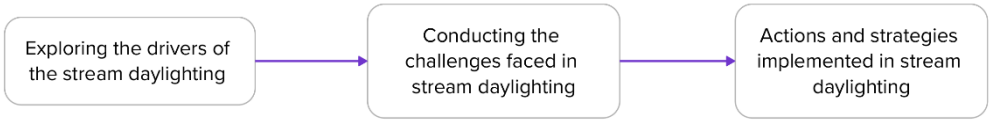

Figure 2.1 Conceptual Document Review Map

(Source: Created by the author)

The objective of this conceptual framework is to understand the major drivers of "stream daylighting" in international case studies and describe the experienced challenges in different phases of the implementation projects. This was followed by listing the actions and strategies applied during the daylighting processes. This understanding effort, in general, provided a basis for the thesis with respect to explore barriers to 'Stream Daylighting" in the context of Ankara.

The most recent studies on stream daylighting (e.g. Khirfan, 2020; Wantzen et al., 2022) focus on global case reviews, expert insights and interviews presenting cases from Global South and Global North countries. Drawing from comprehensive datasets on stream daylighting research and projects, this study selected project-based case reviews from both peer reviewed resources and grey literature (see Table 2.2).

Table 2.2 Selected Case Studies and Sources

Case Study Number	Publication Type	Names of the Cases	Author (Year)
1	Masters Thesis	Tibbetts Brook Daylighting, New York, USA	Molnar, 2022
2	Review Article	The Zurich Stream Daylighting Program, SWITZERLAND	Wantzen et al., 2022
3	Review Article	Periurban Daylighting (includes several cases), FRANCE	Wantzen et al.,2022
4	Review Article	Emscher River Restoration, GERMANY	Wantzen et al. , 2022
5	Review Article	Daylighting The Godavari River, INDIA	Wantzen et al., 2022
6	Review Article	CHINA (includes several cases)	Wantzen et al. ,2022
7	Review Article	TAIWAN (includes several cases)	Wantzen et al. ,2022
8	Journal Article	UK (includes several cases)	Wild et al.,2011
9	Journal Article	The Cheong Gye Cheon Restoration Project, Cheonggyecheon River, Seoul, KOREA	Shin & Lee,2006
10	Masters Thesis	Hastings Creek - Vancouver, CANADA	Jones,2001
11	Journal Article	Restoring Streams in Rural Community, USA (Arcadia Creek, Michigan ; Cow Creek, Kansas ; Fox River Restoration Project, Illinois ; Little River Walk Restoration Project, Kentucky ; San Luis Obispo Creek, California- General Review)	Hoobyar,2002
12	Institutional Report	Darbee Brook, Roscoe, New York, USA	Pinkham,2000
13	Institutional Report	Strawberry Creek, Berkeley, USA	Pinkham, 2000
14	Institutional Report	Jolly Creek, Arcata, USA	Pinkham,2000

Table 2.2. (continued): Selected Case Studies and Sources

15	Institutional Report	Port Angeles, WA, Valley Creek, USA	Pinkham,2000
16	Institutional Report	Berkeley, CA: Blackberry Creek, USA	Pinkham,2000
17	Institutional Report	Urbana, IL,Embarass Creek,USA	Pinkham,2000
18	Graduate Research Paper	Urban Creek Daylighting Project:,Wildcat Creek at Davis Park ,CA , USA	Lennon et al. ,2022; MIT, 2012
19	Journal Article	Indian Creek,FL, USA	Buchholz et al., 2016

A total of 19 case studies were included in the review, selected for their relevance to descriptions of drivers, challenges, actions and geographical diversity. The cases were primarily categorized by country and city level, with additional differentiation based on the scale of implementation. This categorization was further refined by introducing a column to differentiate between national, city, and local-scale projects. In general, most case studies focus on city-scale projects implemented by local municipalities.

2.2.2 Policy Document Review

Before reflecting the literature review in the fieldwork, I reviewed previous studies on Ankara's rivers and streams. Due to the insufficiency of academic studies on this topic, I explored the current issues related to city's infrastructure through media analysis, including documentaries, news pages and non-academic publications. Moreover, I reviewed grey literature such as policy documents, development plans, strategical plans and institutional reports. This enabled me to identify the main stakeholders responsible for the issue, and I tailored my interview questions to focus on the city center, aligning with the contextual insights derived from the literature, policy and planning documents.

Table 2.3 Reviewed Plans and Policies

Institution	Name of the Document	Scale
Ministry of Environment, Urbanization and Climate Change	Climate Change Mitigation Strategy And Action Plan 2024-2030	National Level
Ministry of Agriculture and Forestry	National Basin Management Strategy (2014-2023)	National Level
Turkish Water Institute (SUEN)	SUEN Strategical Plan (2024-2028)	National Level
DSI - State Hydraulic Works	DSI Strategical Plan (2024-2028)	Regional Level
Ankara Metropolitan Municipality (ABB)	ASKİ Master Plan (2024-2054)	City Level

2.2.3 Semi Structured Interviews

In order to explore the ways in which representatives of public authorities, NGOs, and academia perceive the challenges to stream daylighting, I employed semi-structured in-depth interviews with snowball sampling method.

Semi-structured interviews are the type of interview format where the interviewer has objectives to meet but more freedom to lead the dialogues for needs of research that she or he finds important. The descriptive aspects of the interview, such as asking "How did it happen?" "What happened?" or "Could you describe the situation too?" gives the edge to the interviewers to obtain the respondent's explanation of the phenomenology rather than leading the respondents to reflect from a more theoretical perspective. During the semi-structured interviews, the interviewer can be flexible with the ways of asking questions serving the initial purpose of the interviewer's purpose of obtaining data (Brinkmann, 2013).

Through the in-depth interviews the researcher can acquire deeper and richer knowledge the participants yield. Nonetheless, the interviewer has to invest a considerable amount of time both for the data collection and analysis (Jennings, 2005).

The snowball sampling method is a multistage sampling technique, starting with a sample of units, expanding the samples until it reaches a saturation point, and repeating the same patterns in content analysis. The second part of the research is exploratory research (Krippendorff, 2019). I started with an initial pilot interview, expanded my samples with the interviews using the social networks of relationships about the discussed topics, and using the suggested people who are most related experts. Three groups of people representing public authorities, NGOs, and academia were interviewed. The following table shows the distribution.

Table 2.4 Interview Representatives

Category	Institution	Number of Representatives
Public authorities	Ankara Water and Sewerage Administration (ASKİ)	1
	Ankara Metropolitan Municipality (ABB)	3
	State Hydraulic Works (DSİ)	2
	İstanbul Water and Sewerage Administration (İSKİ)	1
Academia	Ankara University (AÜ)	1
	Boğaziçi University (BOÜN)	1
	TED University (TEDU)	1
NGOs	Nature Conversation Center (DKM)	1
	TMMOB Chamber of Civil Engineers	1
	TMMOB Chamber of Urban Planners*	1
**The participant was also affiliated with one of the universities presented above*		

From the snowball sampling method, I reached 13 subject matter experts (n = 13) including participants from academics (n=2), public sector (n=7), and NGO (n=3) groups. I conducted in-depth semi-structured interviews with each participant. The academic experts included specialists in urban water management, climate change

adaptation, international relations and landscape architecture experts. The participants' profiles include department heads and branch managers representing specific organizations, as well as researchers and academics involved in water management and related projects. The NGO representatives comprised activists focused on issues related to stream burial in the city of Ankara. Additionally, I interacted with city planners and civil engineers, affiliated with The Union of Chambers of Turkish Engineers and Architects and a well-known non-governmental organization that aims to protect biological diversity and manage natural resources in Türkiye effectively. Lastly from the public representatives, I had meetings with the public experts of urban transformation, rural planning, and Ankara's water management experts from provincial and regional levels engineers.

To reach out to the people related to the sub-RQ3 I used snowball sampling method. Snowball sampling is a sampling method of reaching the nonrandom samples through a network. The researcher first begins with one person then reaches the interrelated information-person related to the case. It is often visually represented using a sociogram (Neuman,2012). This is suitable for the nature of this study as there is a lot of informal and unknown information that can be detected. In this study each participant suggested other institutions and people so that the interviewees pool gradually got broadened.

In the interviews, first I did a small presentation to explain the context of the stream daylighting and the method of this study. This was primarily necessary as some of the participants did not know the applications in real life of the stream daylighting and understand the questions framework. The semi-structured in-depth interviews were necessary due to several reasons. It provided the necessary flexibility to establish trust and understanding with the participants, especially given the sensitive nature of urbanization topics within governmental bodies. Additionally, the specific context of the interview topics required further attention, and it was important to take the lead during the interviews. With this method I was able to understand the participants' experiences, perspectives, and motivations in depth.

I collected the interview data within a mixed-mode survey, offering the participants the best way suits their survey-taking preferences between face-to-face and video-call interviews. The interviews took approximately 50 minutes to answer the seven open-ended questions. I have recorded the in-depth interviews in video and audio format with the participants' consent and transcript to verbal data. At the same time, for some of the interviews I took notes in respect to the participants' concerns.

The interview questions are formulated according to the document review, content analysis results as mentioned in data collection section. Understanding the **driving forces** behind each stream daylighting case study project and identifying the array of **challenges encountered** by these projects provided the insight to obtain the most effective way within open ended questions. Moreover, the data collected from the interviews provided a much richer context than previously expected, which allowed for new insights regarding **perceived actions** to implement stream daylighting that I incorporated into the data analysis.

2.3 Data Analysis

This study employs both content analysis and thematic analysis to review the literature and analyze interviews. Data from the literature review are analyzed using thematic analysis, while data collected from interviews are analyzed through content analysis.

Content analysis is one of the most used social research techniques, for the interpretation of textual data examining the information according to content. This technique is quite useful for identifying a large amount of data, categorizing it in a more understandable way to discover features that may go unnoticed otherwise. Content analysis is mainly used in descriptive research, while secondarily it can be used in explanatory and explanatory research (Neuman, 2012). According to Krippendorff (2019), the content analysis design requires a few components:

- A body of text to analyze

- A research question to examine the body of the text
- A context of the researcher's choice to discover in the text
- An analytical construct for the operationalization of the context
- Inferences from the analysis
- Validating the evidence

In order to organize the unstructured text, content analysts need to utilize the content into analyzable representations (Krippendorff, 2019). Therefore, I used frequency of mention analysis as an analytical component, interpreting the frequency of codes. This part of the study employs a quantitively evaluation method to analyze how common perception of a theme of the participants views in the interviews and global case study review. However, although frequency indicates commonly discussed topics, it is not a definitive measure of importance. Each finding was discussed comparatively while exploring its relative significance and defining its meaning in its context.

I analyzed the selected case study documents using mainly qualitative research methods. To address these focal points, I used thematic analysis to identify important themes and concepts. Qualitative thematic analysis is a type of content analysis method used in qualitative research design (Kogen,2024). Within a given textual dataset, the thematic analysis methodologically systematizes the themes and identifies the patterns that can be applied for case studies (Squires, 2023, pp. 463–468).

Braun and Clarke (2006) explain the steps of qualitative thematic analysis in six steps (see. Figure 1). In the first phase the researcher gets accounted with the collected data. After that, the researchers produce sets of codes from the most identifiable and common themes. In the third phase, the researchers should analyze the codes and combine some of the themes into overarching themes. In the fourth phase the researcher reviews the themes to find out the sub-themes and outlier themes according to the patterns she observed previously, with a possible use of visual

mapping. Then the researcher ensures the data is aligned and names the themes. Lastly, all the output and analysis are reported.

The coding process supports converting large amounts of data into more useful and meaningful data (Attride-Stirling, 2001).

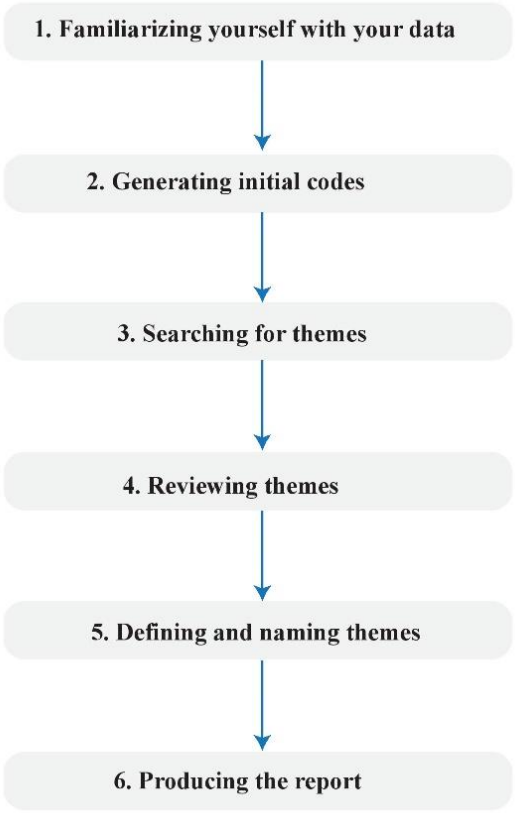

Figure 2.2 The Phases of thematic analysis,

(Source: Produced by the author adapted from Braun and Clarke (2006))

Braun and Clarke (2006) explain that the approach a researcher uses affects the coding scheme. I had predefined three questions to review the case study articles, I applied inductive approach in the coding process where I collected the raw data from the case study articles.

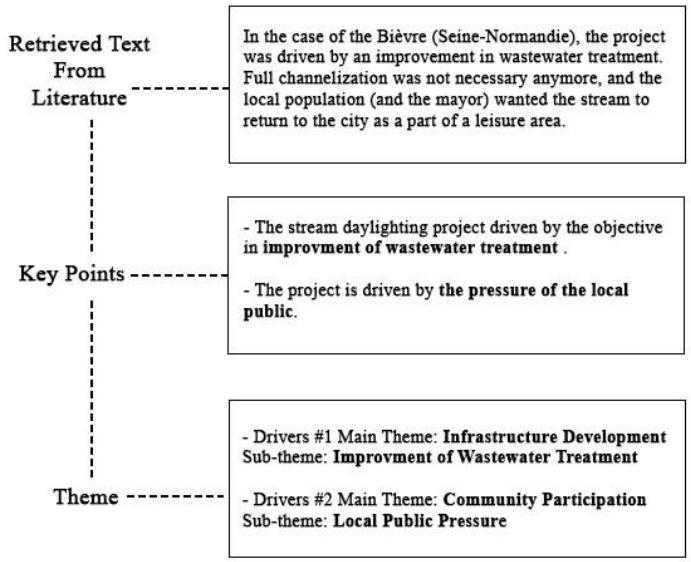

Figure 2.3 Example of Latent Coding from literature modified by author the diagram adapted from Aljedaani et al.(2019)

(Source: Aljedaani, Bakheet & Ali Babar, Muhammad. (2020). Challenges in Developing Secure Mobile Health Applications, A Systematic Review. 10.48550/arXiv.2007.10876.)

After that, I coded the raw data into overarching themes. The global case studies that are selected in this study are only a review of the projects, not all of the sources have common structure referring to specific information such as project costs or technical details. Therefore, in the coding process, I preferred using **latent coding method** where one observes the underlying meanings in the text content (Neuman,2012). For example, Figure 2 demonstrates the improvement of the themes for the driving forces.

In thematic analysis, whether a theme captures anything significant in connection to the research question determines its ‘’keyness’’ (Braun & Clarke, 2006). Therefore, case study analysis aimed to capture the main themes and sub-themes of the research questions.

As I delved into case studies within literature, I focused on three distinct topics capturing the common essence of the divergent examples of stream daylighting within thematic analysis:

a) Understanding the **driving forces** behind each case study project.
b) Identifying the array of **challenges encountered** by these projects.
c) Examining the strategic **actions taken** within the context of each case study.

I used MAXQDA 24 program to create separate excel tables explaining each theme and their codes.

After coding, I grouped the data into broader themes. The thematic analysis involved identifying patterns across the different codes, which were then organized into overarching and sub-themes for each of the topics.

After coding the case studies, I applied a similar strategy in the data analysis of the interviews. I selected data analyzed based on their condensed meanings which summarize them into concise statements while keeping their original meaning. For example, if the quote from an interview is *"The lack of proper urban planning strategies often results in conflicts among stakeholders",* I coded them under the *"Inadequate urban planning leading to stakeholder conflict."*

The interviews bring out a **descriptive narration** which draws out a linkage between the themes. Each theme was interpreted as connected to the initial question I asked them to answer. The analysis of the interview aims to draw broader inferences and reveal a pattern between the themes. The data was evaluated in terms of what each actor said in their own words, in the context of each challenge, and in the context of their responses to the questions asked, and each statement was ranked by **frequency of mention** analysis.

After identifying the themes, I used them to provide insights about the possible challenges and barriers for stream daylighting projects in Ankara. Then, to analyze the results, I imported the transcripts into qualitative analysis software (MAXQDA 24) to facilitate systematic coding. In this part, both deductive and inductive approaches played a part. Deductive codes were based on predefined categories (e.g., " Stakeholder and Public Engagement Issues," "Construction and Flooding Management Issues"), an initial set of codes was developed based on the case study review. The inductive approach allows emerging from the data itself, with the preliminary reading of the transcripts allowing for themes not anticipated previously in the case study document review.

For the non-recorded interviews, during the interview, I coded the answers both using a repeated set of codes and recording new findings. Furthermore, in the analysis chapter of the interviews, I used participant quotes to illustrate each theme and give voice to the stakeholders' perspectives to reflect their experience.

All of the results were interpreted and explained in several ways. The **case study review** aimed to emphasize global challenges, while the research findings focus on specific local concerns. I combine detailed **descriptions of global cases** with the **context-specific findings from Ankara** to create a layered understanding. The interpretation connects broader patterns (e.g., Economic Interest Management in global cases) with localized challenges (e.g., unique financial considerations in Ankara such as Project Costs and Unpredictability). Meanwhile explaining the research findings, I built a storyline integrating findings into a **narrative** that addresses the research question.

Sheydayi & Dadashpoor (2023) in their systematic review of how content analysis is used in the field of planning and urban studies, proposed a methodological model. This procedural model proposes a content analysis method specifically for the planning and urban studies for qualitative content analysis. There are five steps of this procedural method:

1. Defining the study's objectives
2. Identifying the subject field and selecting the type of data to analyze
3. Selecting an appropriate method for condensing and coding the data
4. Determining the approach for interpreting the codes
5. Describing how the interpretation results will be applied

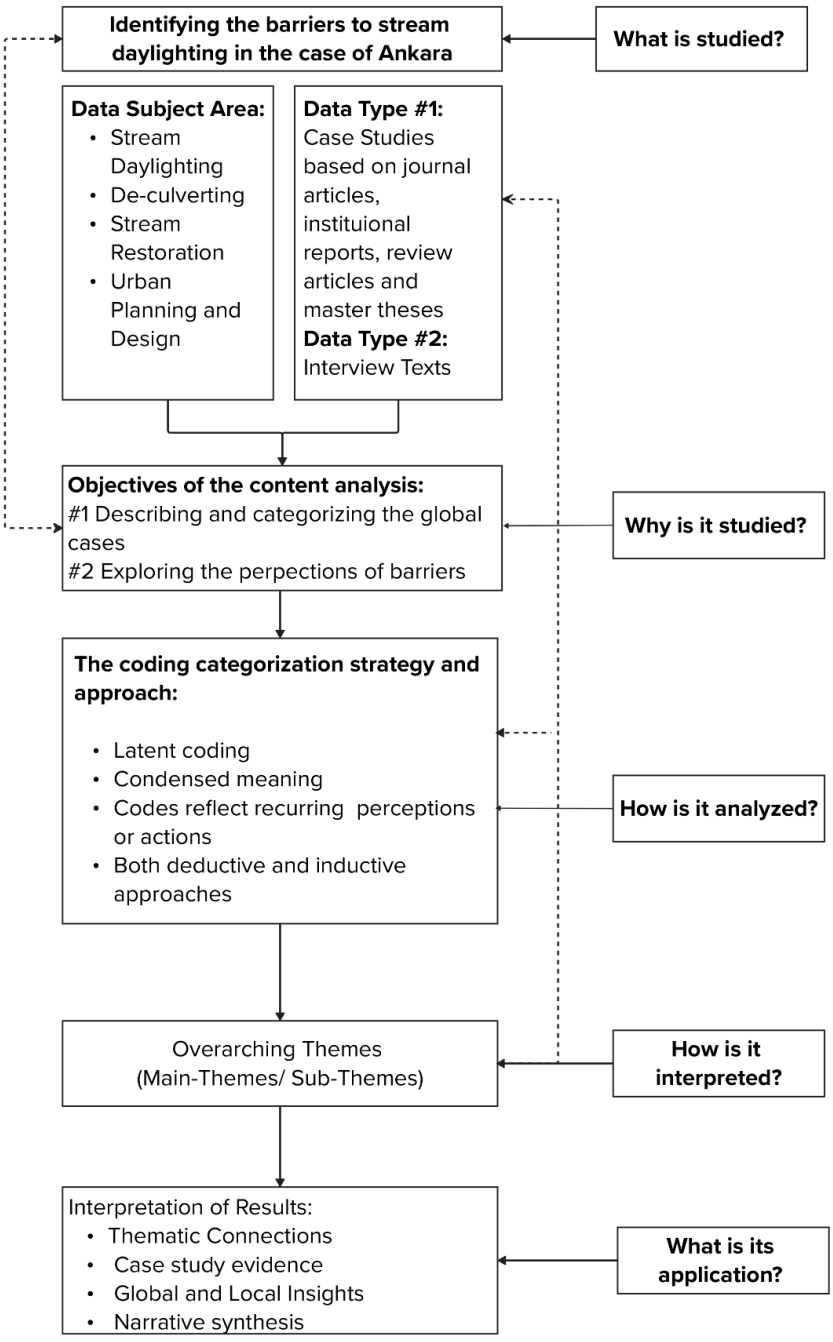

Figure 2.4 The steps of this research procedural method explaining data analysis method

(Source: Produced by the author inspired from the Sheydayi & Dadashpoor (2023)'s model designed for urban studies)

Figure 2.4 summarizes this study's procedural method in content analysis inspired by this model.

2.4 The Case Study of Ankara

Before selecting Ankara as the focus area for stream daylighting research, I reviewed relevant literature to identify the environmental, social, and institutional challenges surrounding urban water management in Türkiye. This review included an examination of historical and current policies, practices, plans and studies, with particular attention to the concept of "Dere Islahı''. Findings show that Ankara, as an exemplary city, reflects the structural problems developed during rapid urbanization that continue to persist today. Therefore, it embodies the complexities of stream management and provides fertile ground for exploring the potential of stream daylighting as a solution.

This part begins with an overview about the stream management in Türkiye, focussing on the stream reclemation context both in the national level and city levels. Following this, it briefly summarizes the historical processes of stream management in Ankara. Finally, it discusses the risks posed by climate change in Ankara.

2.4.1 A Historical and Policy Perspective on Stream Management in Türkiye

Water management has gained increasing importance globally over the past 50 years, with summits addressing its social, environmental, economic, and legal dimensions. Türkiye actively participates in these discussions. As an EU candidate, Türkiye aims to manage its water resources sustainably through a basin-based, integrated approach, ensuring their protection, development, and control (Avcı,2021).

Reviewing the historical development of the water use in Türkiye context, based on the study of Burak & Mat (2019) about the overview of urban and industrial water use and management in Türkiye has experienced a high rate of urbanization, with a rate of 18.5% in 1950, increasing to about 62% in 2000 and then to 81% in 2017. This fast development causes serious environmental issues, especially on water bodies within industrial and urban pollution. Burak & Mat (2019) outlines that, urban development plans are incompatible with the rapid population growth and urban developments patterns. In addition, the plans usually do not meet with another intersecting plans' objectives and do not follow the projections, leading to increasing urban congestion, particularly in metropolitan municipalities with inadequate infrastructure facilities (Burak & Mat, 2019). The drainage and streams systems are affected by the lack of holistic water policies, administrative problems, negative land treatment approaches that cause land division in water ecosystem, implementing laws against protection of riverscapes, and enforcing unsustainable treating approaches in water management. (Dinç,2019). Considering these facts, there is a growing need to understand the context of stream management practices from watershed scale to reach-stream scale in metropolitan areas in Türkiye.

Water-related policies require cross-sectoral coordination within a common water law framework. Some of these sectors include industry, energy, mining, tourism, environment, agriculture, and drinking water.

The inadequacy of Türkiye's current water management system is widely recognized by stakeholders, including the Ministry of Agriculture and Forestry (General Directorate of Water Management). Avcı (2021) emphasize that despite numerous legal and administrative regulations, the country lacks a unified water policy, leading to significant legal and institutional confusion. Ministries have their own policies, but there is no overarching national framework.

As Avcı (2021) restates these key issues includes:

- Fragmented solutions covering only specific water bodies

- Policies disconnected from each other and other sectors
- A focus on meeting isolated water demands rather than holistic planning
- Water management based on administrative boundaries
- Governance approaches that fail to include all relevant actors
- Lack of inter-institutional coordination
- Shortage of experts in water law and policy
- Absence of a national water plan and water law

The Ministry of Forestry and Water Affairs (General Directorate of Water Management) has also identified additional concerns:

- Outdated and fragmented legal regulations that fail to meet current needs
- No legal provisions for integrated management of water quantity and quality
- Confusion over the legal status of water (public vs. private)
- Institutional overlap and inefficiencies due to redundant policies

Furthermore Kocabaş (2024) emphasize that in terms of water resource management full integration with spatial planning legislation has not been achieved. Gaps in planning regulations, lack of coordination in governance, authority conflicts, inter-institutional miscommunication, and database deficiencies have hindered the protection of natural resources, particularly water resources, in the urbanization process (Kocabaş,2024).

Understanding these challenges are particularly significant before evaluating the stream management and *dere ıslahı* (stream reclamation) in Türkiye. Without a national framework that prioritizes holistic planning and governance, the implementation of water-sensitive urban planning can be challenging.

There's no direct translation as a practice to stream daylighting in Türkiye context, as stream or river regulation projects referred by "Dere Islahı". Bahçeçi (2014) defines "Dere Islahı" as channelizing or burying streams for the purposes such as: creating protective facilities against flood waters, establishing irrigation facilities, drying swamps, solving the drinking water and sewerage problems of cities and

towns, improving streams and making them suitable for transportation if necessary. The most common problems “Dere Islahı” projects caused can be referred as: disregarding of ecological and biological process of the project area, limited cross sector and/or cross border cooperation, lack of legally binding policies and obligation, floodings, urban sprawl and land ownership issues (Bahçeçi, 2014, p.41).

Mainly, the concretization constructed by “Dere Islahı” projects cause cutting of the connection between water and soil resulting in terrestrial ecosystems transforming into concrete channels.
Transforming levees and streams into channels significantly changes the water flow and storage capacities of riparian zones. Once the structure of the river ecosystems that filter sediments, the ecosystem services and functions decrease significantly to reduce floods and regulate water quality. Revegetating these destroyed ecosystems is a very difficult and expensive endeavor. “Akarsu ve Dere Yataklarının Islahı Genelgesi”, the notice for the improvement of streambeds, published by the Prime Ministry in 2010, reflects the streambed improvement process of building walls against floods (Yıldız,2016; Başbakanlık Mevzuatı Geliştirme ve Yayın Genel Müdürlüğü, 2010).

As pointed out by Özden (2020) the dominant reason for the stream burial process in Türkiye, especially in new urbanized cities, is the procedure of conventional engineering methods for the infrastructure system. Kocabaş et all. (2018) observes that the stream bed improvements are carried out entirely by imitation method and civil engineering calculations as biological process is being ignored. The natural materials are almost never used, and water resources have not been rehabilitated for aquatic creatures, especially fish, and no significant work has been done in this regard.

Also, Kocabaş et al (2018) argue that the policy and institutional structure in water management still reflects no renewing attempts even though effected by the dreading

water pollution. According to Kocabaş et al (2018), there is a lack of cooperation between institutions. This is due to the project institutions do not receiving professional help from employees who work and are knowledgeable on this subject. After the politically connected official working in the institution decides what will happen in the project, the subcontractor finalizes the project the way they want.

In terms of stream restoration, flood, and water management, Ankara is supported with various policy contexts from local to regional scales. (see Figure 2.5)

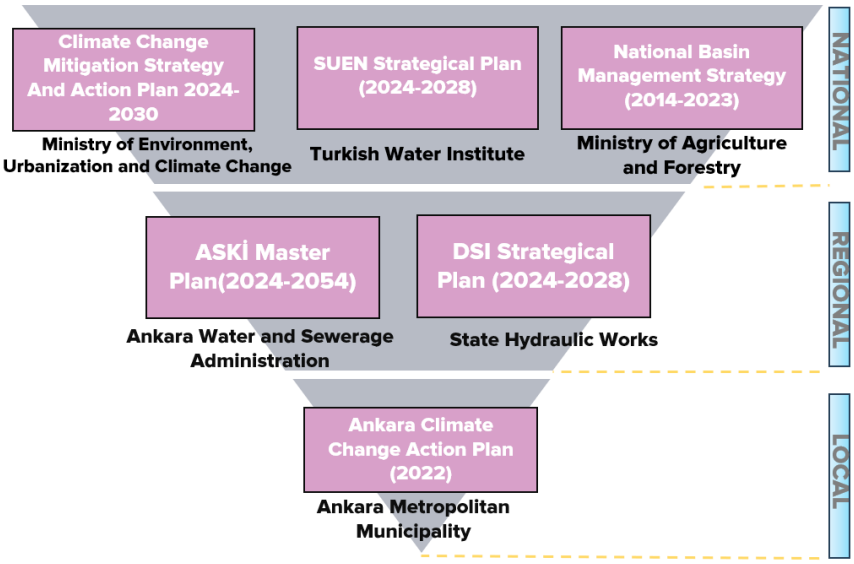

Figure 2.5 The political documents related with Ankara's stream management

(Source: Produced by Author)

The National Basin Management Strategy aims to preserve and restore **watershed areas and control urban development** to maintain environmental health and natural resources. SUEN aims for national and international activities with sustainable water policies and contributes to the generation and development of strategies. The Climate Change Mitigation Strategy and Action Plan of 2024-2030 aims to enhance ecosystem protection, prioritize green, nature-based solutions (NBS) that increase carbon sequestration capacity over gray infrastructure solutions,

and promote projects and efforts aimed at the restoration and rehabilitation of river corridors and ecosystems in agricultural, pasture, wetland, and settlement areas.

The ASKİ Master Plan - The Ankara Water and Sewerage Administration Master Plan aims to ensure sufficient, high-quality water supply, effective wastewater management, and **flood prevention to protect human health and property** by 2054.

Most importantly for the stream daylighting **Ankara Climate Change Action Plan (2022) of Ankara Municipality involves** an action plan **rehabilitating high flood-risk streams by daylighting them** and implementing risk reduction measures, **enhancing the permeability of the stream beds** and **integrating them with green spaces**, and deculverting city streams to integrate them with open green areas.

2.4.2 Historical Overview of Stream Burial in Ankara

Additionally, prior research, including İdali's (2020) feasibility study on potential stream daylighting sites within Ankara's urban center, highlights the city's suitability as a case study. These insights, combined with strategic policies such as the Ankara Climate Change Action Plan (2022) from the Ankara municipality, form the basis for selecting Ankara as the study area to explore the feasibility and challenges of stream daylighting within the Turkish urban context.

Ankara, the capital city of Türkiye, is located in the Sakarya, Konya, and Kızılırmak Basin and is the second most populous city in the country (ÇED Ankara, 2022; TÜİK 2024). Ankara Rivers originates near Akköprü, where the Çubuk and Hatip Rivers converge with the İncesu Stream, and flows approximately 140 kilometers before joining the Sakarya River (Eker & Özkan, 2017, p. 209, as cited in Çetiner & Şahin, 2020). Four main rivers flow through the city, as Çubuk Stream, Hatip Stream, İncesu Stream, and Dikmen Stream, have been partially covered and partially left open for flood control by the State Hydraulic Works (DSİ) (ABB,2009). Although

the traces of its rivers and streams have become less visible today, they played a significant role in Ankara's historical urban development and natural landscape.

As explained in detail by İdali (2020), Ankara has been experiencing a negative impact on rivers due to uncontrolled rapid urbanization since the 1950s. The first urban plan of the city, the Jansen Plan, restricted construction on the valleys and instead included a plan for a stormwater management system, however, it failed to be established. Historically, there were numerous instances where the actions taken to address the burial of streams, due to evoked negative responses from the public and perceived as a conventional solution. Firstly, due to the great flood disaster in 1957 in the Hatip Stream catchment area, there was major destruction of the city center of Ankara and numerous fatalities. In addition, as urban streams generally provoked negative emotions for public health and set real estate values at risk, many streams were buried for further construction supporting the urban infrastructure such as roads or sewage lines. İdali (2020) outlined that, feeding this cycle, there was an increase in agricultural activities on these lands, and the waste spillage reported by the State's Hydraulic Works Institute (DSİ).

In terms of the blue-green infrastructure Görmüş et. al. (2023) has evaluated the city plans in connection with the streams. Görmüş et al. (2023) found out that all the plan decisions reflected the idea of protecting valleys systems as with the following plans within the historical development of Ankara:

- In the Lörcher Plan (1925–1932), the concept of green spaces developed in connection with urban streams included recreational opportunities.
- In the Jansen Plan (1932–1957), it was proposed to preserve the Ankara River, Bent Stream, Cevizli Stream, Hatip River, İncesu Stream, Kavaklı Stream, and Kirazlı Stream as part of the open green space system, aiming to integrate valley systems with recreational areas.

- In the Yücel Uybadin Plan (1957), an Olympic complex (Gençlik Parkı) was planned around the İncesu Stream.
- In the 1990 Ankara Master Plan, afforestation areas were proposed to the east and northeast of urban center. Along with the idea of keeping these areas outside residential zones, a greenbelt concept was developed to protect ecologically significant areas. In the plan, the Hatip River Valley was intended to be preserved as agricultural land, serving as a continuation of the green axis.
- In the 2015 Structural Plan Decisions, green corridors incorporating urban valleys were developed. As an important air corridor for the city a greenbelt, which included these green corridors, was proposed.
- In the 2023 Master Zoning Plan (Nazım İmar Planı), the decisions were emphasize to preserve the ecological characteristics of valleys and waterways.
- In addition to the urban plans of the city, The Great Ankara Sewerage Project (BAKAY), aimed to create a comprehensive and holistic rainwater and sewage system to these problems instead of relying on temporary solutions (ABB,2009). The project was developed in 1989 for the implementation projects of sewerage and stormwater networks, collectors, central discharge, and interceptor canals in order to meet the needs of the population of the capital Ankara, which is estimated to reach 5.500.000 people in 2025 (ASKİ, 2023). However, this project has not yet been completed, as some parts remain incomplete, and Ankara has no effective stormwater drainage network (IMO Ankara, 2022, ABB,2009).

In response to the all the planning strategies preserving the ecological values and open-green spaces particularly based on valley system did not achieve success conversely it transformed focal points for urban profit within the renting system (Görmüş et al.,2023). This reflects the contrast between the plans and the implementations in metropolitan Ankara.

Like many water infrastructure projects in Türkiye, the Ankara Stream and its streams have been lost over the years due to river and basin regulation projects, or stream or river regulation projects within the scope of 'Stream Reclamation' (Dere Islahı). This caused almost all dry or flowing streams to gradually transform into channels for carrying sewage. The tension between economy and ecology has led to political decisions generally being made in favor of economic interests. As a result today, in the city center in a 100 km2 area, a 56 km long watercourse has disappeared from the surface, and the city center is deprived of a huge amount of water surface of approximately the size of 22 football fields (İdali, 2020; ASKİ,2023; IMO Ankara, 2022).

Addressing all these problematic issues, a documentary called “Streams Beneath the Asphalt!” (Asfaltın Altında Dereler Var) was created by a group of activists dedicated to uncovering the paths of the lost streams and advocating for their restoration. The documentary directed by Semiz (2019) explores the hidden streams of Ankara, which flow underground beneath the city's streets and avenues. The film explores the history of these lost streams, analyzes their presence in historical photographs and maps, and emphasizes efforts to reopen, deculvert, and restore them, garnering media attention.

2.4.3 Climate Change and Environmental Risks Related to Stream Burial in Ankara

As a part of closed and open river basins, Ankara's historical and contemporary actions of patterns of stream burials seriously damage the ecosystem's health and well-being. Rivers and streams have been channeled, their flow directions altered, and approximately 100 seasonal streams have been covered, effectively eliminating them contributed to the disappearance of Ankara's river systems (Anonymous, 2019, as cited in Görmüş et al., 2023). Recent increasing unsteady climate change events with intensified urbanization related to river channelization cause frequent floods,

droughts, or erosion, resulting in more damage to the functions of the natural systems.

One of the most visible events is the increase in the frequency and severity of flooding events over recent years. Climate change is impacting both the quantity and quality of water, as well as the ecosystems dependent on it, leading to long-term problems such as urban floods, decreased snowfall, and reduced water resources in the city of Ankara (ABB, 2022). Cited as in Köse & Şahin (2024), emphasize that within an increase in the number of flood events in Ankara River Basin in recent years was mainly exacerbated by several reasons all contributed to an elevated flood risk. Such as the reduction of green spaces, the rise in urban development, existing infrastructure deficiencies, inadequately designed drainage systems, and errors in river rehabilitation efforts. Particularly, the city's center suffers from inadequate rainwater drainage systems, which prevent effective channeling of rainfall into these main rivers. As a result, flooding disasters occur even during moderate rainstorms, causing both human and material loss (ABB,2009). According to Oruc et al. (2022) over the past 20 years, heavy rains and flash floods in the Sakarya basin region, which includes Ankara, have already caused significant damage and loss of life. In the years 2071-2100 the region will likely receive less rainfall compared to 1971-2000. The area will also experience fewer extremely wet days, potentially leading to more intense rainfall when it does occur. Yılmaz & Erçoşkun (2020) mentions that flood disasters in Ankara are not coincidence, but a result of historical mismanagement of natural streams by polluting the rivers, converting them into sewer lines or underground culverts. This is significantly exacerbated by poor transportation planning of the city, as poor transportation decisions taken in the past and today cause loss of life and property. Therefore, floods on roads, underpasses, multi-story intersections, some public institutions, and metro stations continue to occur (Yılmaz & Erçoşkun, 2020). Furthermore, the results of the flood risks assessment study by Köse & Şahin (2024) demonstrates that areas with high flood risk are observed to be near the river, with sparse vegetation and continuous urban

zones. Moreover, they observed that the proportion of areas at flood risk increased in the last century.

Another significant environmental concern is the stream pollution. According to the study of Atıcı & Ahiska (2005) Ankara's stream pollution is on a critical level, which is considered in the highest level of pollution a stream can reach 'polysabrobic zone'', due to the wastes coming from self-feeding sources and the pollution load it carries. This has a serious negative impact on organisms that form part of the food chain and are sensitive to environmental changes (Atıcı & Ahiska, 2005). In the city the areas lacking sewer systems, particularly in gecekondu (squatter) neighborhoods, present a significant threat to environmental health. The combination of the pollution of streams and the inability to build treatment plants for wastewater reported as eliminating the possibility of considering the streams as part of the city's green system (ABB,2009).

Thirdly, urban heat island risks are reported as a significant threat in Ankara in relation to the climate change affects. The Ankara Climate Change Action Plan (2022) provides an analysis of the risks of climate change in Ankara. One of the critical parts of this study in relation to stream management is the 'Urban Heat Island Risks'. Firstly, Ankara's bowl-shaped land structure, densely constructed lands prevents airflow and causes serious heat island effects. The surface temperature maps of Ankara demonstrate that the open large green spaces, rural areas, and urban forests are the coolest regions of the city. These regions include Anıtkabir open green spaces, Atatürk Forest Farm (AOÇ), the cemeteries such as Cebeci and Karşıyaka, military zones, and the Middle East Technical University (METU) forests (ABB,2022).

In contrast, the dense urban areas differ in temperature up to 5-7 °C. The action plan explains that, in the scenario of intensive and unplanned land use changes and the shrinking of natural areas, the average heat temperatures of the city are going to increase further, and the urban heat island is going to intensify (ABB,2022).

Additionally, the analysis reports that the urban heat island effect intensifies due to the occupancy-vacancy ratio, particularly in the city center. This is mainly due to the lack of green spaces, which do not meet the minimum standard of 10m² per person (ABB,2022).

In response to these risks the climate action plan (ABB,2022) suggests critical sub-actions in relation to this study. By leveraging the existing valleys to increase the air corridors in the city within continuity in the north-south direction of the city can contribute to reducing the temperature. Furthermore, re-opening the streams by re-designing the stream surroundings can create natural cooling corridors for climate change mitigation and adaptation.

CHAPTER 3

STREAM DAYLIGHTING: INSIGHTS FROM GLOBAL EXAMPLES

This chapter explains the global content of stream daylighting practice and stream restoration in literature in order to understand the basic concepts. Chapter 3 is divided into two parts; the first part refers to the terminology and the background of the concept of stream daylighting, and the second part identifies the barriers of stream daylighting based on the case studies evaluation on thematic divisions.

3.1 Understanding Stream Daylighting

3.1.1 Geomorphology of Streams and Rivers

Streams are interconnected systems, where there is an interaction both between streams and the surrounding landscape. The natural physical characteristics of streams provide many benefits destroyed and modified by anthropologic activities. To understand the stream burial and daylighting process, there is a need to read landscape pattern/configuration, its spatial and temporal context at a basic level (Fryirs & Brierley, 2012a).

As part of the hydrologic cycle, water moves between stages and reservoirs, in sea, land and atmosphere. Evaporating, transpiration, condensation, precipitation, and recovery to the ocean through rainfall and groundwater are all major processes in the **water cycle** (Schulte, 2023).

A **stream** is a body of water moving both surface and groundwater. Streams refer to the flow of the waters moved through naturally by the gravity on landscape. It can be in diverse sizes and shapes, such as brooks, creaks, or rivers. The streams have stages, moving from higher elevation like mountains

to lower elevations like ocean. Water creates rills, or tiny channels, with the slope. As one stream flows into another larger channels are formed as rills combine. As a result, a system of rivers and streams called **river tributary** is formed (Schulte, 2023).

In **stream order**, a stream which has no tributaries is the first order or the main stem. The highest order stream in the system has a flow of discharge that contributes to all smaller streams. The smallest unit in the river network referred to as **river reach** is also used in the scope of engineering called river reach scale (see Figure 3.1.).

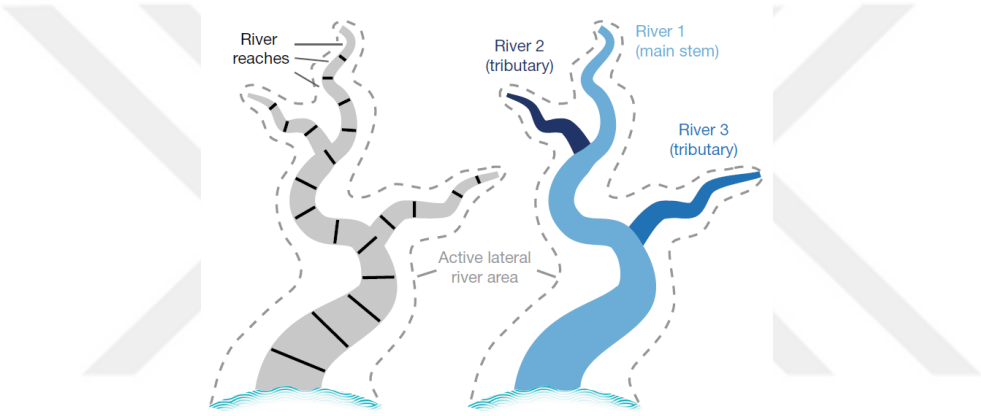

Figure 3.1 River tributaries, main stem and river reaches

(Source: Grill et al., 2019)

The moving stream constantly erodes streambeds. The stream breaks the bank's outermost edges by lateral movement to form a **floodplain**. Floodplains are flat areas around river channel produced by overbank deposition. Floodplains are also experiencing periodic flooding. Due to the deposition of nutrient rich sediment during floods, floodplains are often fertile and suitable for agriculture (Schulte, 2023; Trice,2013; Floodplain| River Dynamics, Erosion, Sedimentation | Britannica, n.d.)

Stream **headwaters** are where rivers are born, they are often found in steep gradients of landscape such as mountains. The river network's biggest

waterways are farther upstream from their end or confluence with another stream. Headwater streams offer several benefits to ecosystem such as mitigating floods, providing fish and wildlife habitat, recharge groundwater resources, filtering pollution and purifying water, and contribute to the health of downstream rivers, lakes, and bays (Streams | Rivers & Streams | US EPA, 2013). Therefore, headwaters are critical for the overall health of a river system. They can consist of rich biodiversity, supporting various aquatic organisms adapted to specific conditions (Meyer et al., 2007).

Elmore and Kaushal (2008) emphasize that headwater streams play a vital role in the broader river network, making their protection essential for the conservation and restoration of downstream ecosystems. Headwater streams are often drained and sewered when they are developed for the purpose of residential, commercial or industrial use resulting in reduced drainage volumes and density. Given that headwaters are relatively small streams, they degraded and altered in hydrological connectivity with various land uses. Primarily, small headwater streams are the most vulnerable stream groups to the urbanization trend (Elmore & Kaushal, 2008; Freeman et al., 2007). They are most likely to be ignored by legal protections due to lack of understanding of the ecological benefits of the public.

Napieralski et. al (2014) interpreted that especially in the 19th and early 20th centuries, small streams were channelized to facilitate drainage and expand agricultural areas. This resulted in the loss of stream network and their visibility on maps, as well as limiting the ability to define their spatial characteristics and their physical or ecological functions (Meyer et al, 2001; Wohl,2017). For example, (see Figure 3.2) by 1980, many streams of Zurich either flowed through culvert or were routed into combined sewers (Broadhead et al.,2013).

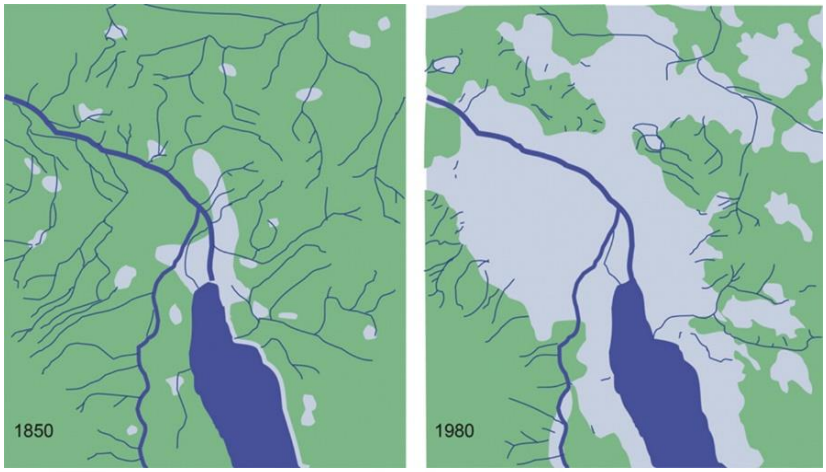

Figure 3.2 Stream Loss of Zurich due to urbanization

(Source: Broadhead et al.,2013)

A catchment area, which is also called **watershed system**, a land of body that surface water flows and connected by a network of channels. The watersheds can be examined under the relationship over a range of spatial and temporal scales. (Schulte, n.d,; Fryirs & Brierley, 2012a) It is physically defined as a dividing ridge between drainage areas (Merriam-Webster, 2023). However, its significant to remember that the boundaries of the watershed go beyond administrative and political boundaries.

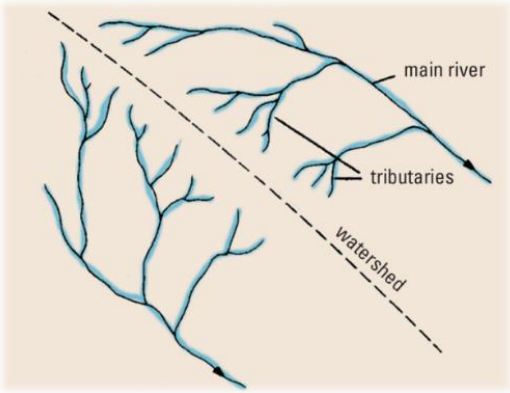

Figure 3.3 Watershed Diagram

(Source: Collins Dictionary of Geographical Terms, 2015)

Usually, stream daylighting is often taken in process watershed or catchment areas to address various issues. The **watershed level planning** in the stream daylighting project contributes to the natural flow and connectivity of the larger catchment area by returning the stream to the surface.

For a successful implementation of stream daylighting, a project needs to consider the morphology of natural stream channels. Therefore, the morphology of the channel explained with ‘’**Channel geometry**’’ referring to the three-dimensional form of a channel. The channel size and shape are influenced by erosion and depositional processes along the riverbank (Fryirs & Brierley, 2012b).

Watershed **stream valleys** serve as primary pathways for water flow, typically containing a river. These valleys are shaped by geological processes creating various types of valleys such as U-shaped, V-shaped or flat floored valleys. The valleys are shaped for a long duration of times with the erosion, transport, and deposition of sediment. (Schulte, 2023).

A widely used method for classifying valleys and streams, developed by Rosgen (1996), is based on their geomorphic and hydrological characteristics. This classification system is commonly employed in river and stream restoration projects, as well as in environmental assessments by U.S. government agencies (Natural Resources Conservation Service, 2007).

Figure 4 presents the Rosgen Classification System, which divides streams based on channel shape, slope, and pattern, categorizing them into stream types "A" through "G." For example, while Type A is straight channels with a uniform width and depth commonly found in steep lands; Type C is meandering channels that commonly found in low gradient plains (Fundamentals of Rosgen Stream Classification System | Watershed Academy Web | US EPA, n.d.).

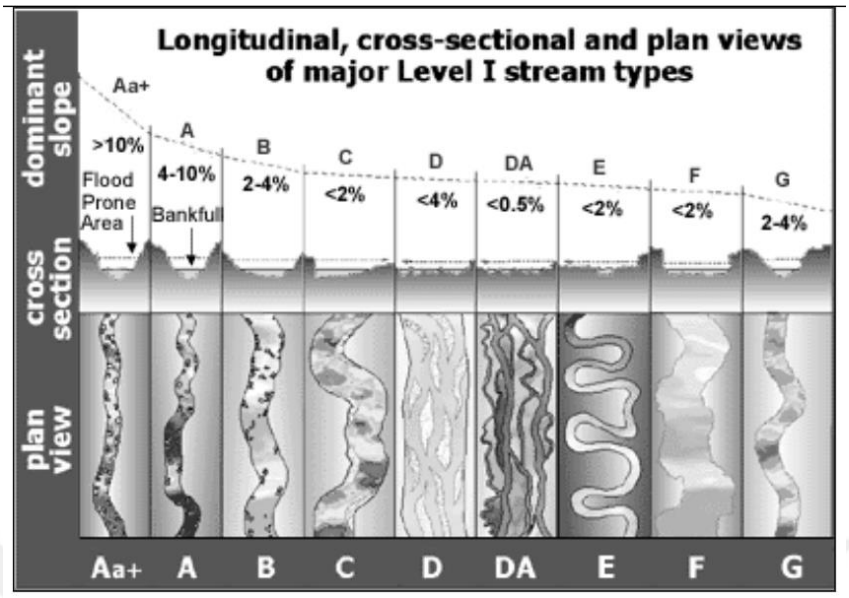

Figure 3.4 Rosgen Stream Clasification

(Source: Watershed Academy Web | US EPA, n.d.)

In terms of evolutionary trajectory of the streams Castro & Thorne (2019) suggest that these classifications such as Rosgen are only a conceptual model to understand the structure of streams. However it is important to consider the other factors such as biological factors rather than framing the system solely within physics-based fluvial geomorphology. Streams can have various drivers of evolution depending on its catchment, landscape, and management contexts. This perspective is crucial for the natural river restoration and encouraging thinking beyond traditional approaches.

Another important part of the water cycle is flooding. Flooding occurs as a result of increases due to higher discharges of water. Allaby (2013) explains that the increased discharge also expands the stream's cross-sectional area, causing the channel to fill and the water level to rise.. The banks may be overflowing and spilling into the surrounding floodplain, which is called bankfull discharge or bankfull stage. Depending on the stream, the frequency of flooding or discharges may be different (Allaby, 2013).

For stream health **riparian zones** have to be maintained. Riparian areas serve as buffers between land and water. They are critical for many plant and animal species including the combinations of aquatic and terrestrial habitats. In addition, riparian zones provide a large range of essential ecosystem services, e.g. to filter pollutants from the water, manage floods, improve soil health or local climate regulation.

Natural rivers have ecological and **hydrological connectivity**. Wohl (2017) described this as river connectivity or hydrological continuum, within the watershed and the river corridor. River connectivity happens in longitudinal, lateral, and vertical dimensions differs in spatial and temporal scales. The action of rivers against ecological and human disturbances is also influenced by connectivity (Wohl, 2017). By Grill et al. (2019) definition for connectivity dimensions; longitudinal connectivity in the river channel involves the interaction of physical infrastructure, not only within the river channel itself but also in riparian zones and adjacent floodplains. Lateral connectivity in floodplains is influenced by hydrological alterations resulting from river flow changes due to water abstractions or regulation. Grill et al. (2019) continues to describe the vertical connectivity as an extension to groundwater and the atmosphere, affected by alterations in water quality that result in ecological barrier effects. This caused by changes in water temperature or the pollution. There are pressure factors and indicators affecting this connectivity such as river fragmentation, water consumption, flow regulation, urban and road development floodplain areas and riparian zones.

As summarized above, riverine ecosystems are not limited to fluvial and physical processes; they are hierarchical networks that involve interaction between the surrounding landscapes on many levels. Therefore, engineers, designers, planners, and managers must examine and comprehend the system's balance at various levels.

3.1.2 Modification of the Streams and Stream Burial Through the History

Effective river system management requires recognizing their unique characteristics and attributes. It is crucial to understand ecosystem degradation and the history of modifications made to streams. There are gradual built-up effects of stream burial on water quantity and quality. Knowledge of data of stream burial is essential for the effective resource management and restoration of rivers (Weitzell et al., 2016).

There are direct and indirect modifications to the natural system by human alterations. Direct modifications include structural engineering activities to alleviate flooding such as river regulations and channelization. These operations have typically been followed by the removal of riparian cover. Unlike direct modifications, indirect modifications usually refer to unintended results of urbanization such as land use and climate changes (Fryirs & Brierley, 2012c).

There are various ways of modifying the streams, however, Elmore & Kaushal (2008) reports that stream burial where streams are piped, culverted, or paved over is perhaps the most destructive way of modifying the rivers. Stream burial was a common practice during suburban development which disrupt the landscape of the stream by directing a stream into underground pipe (Forgrave,2022). It is difficult to define the direct-causal relationship of the geomorphic change effects; however, stream burial mainly involves the changes in land uses that have indirect effects on the whole watershed area.

For thousands of years, the rivers attracted humans by providing many ecosystem services. As technology continued to develop within demographic and economic development, river engineering also advanced, with consequences for the environment (Haidvogl, 2018).

The stages of evolution in urban hydrologic systems are explained by Kaushal et al. (2015) within the eras of; first an industrial city, secondly a sanitary city with

buried streams and lastly a sustainable city with innovative solutions to deal destructive results of the previous eras (See Figure 3.5).

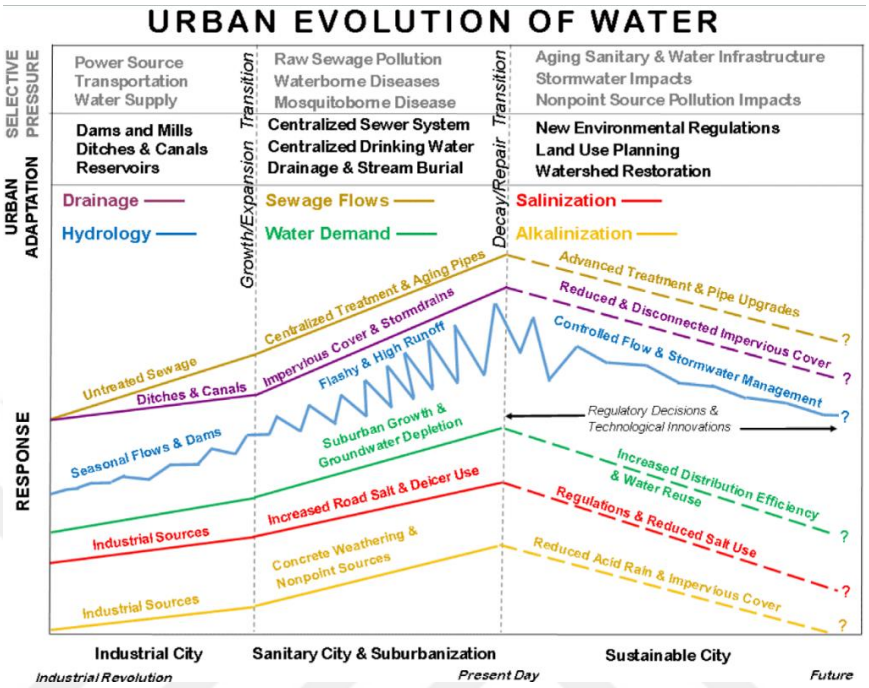

Figure 3.5 Urban evolution of water from the Industrial Revolution to the present

(Source: Kaushal et al., 2015)

According to Haidvogl (2018) rivers and brooks gained strategic importance in pre-industrial times as they were source of kinetic energy, main trade routes for goods, cleaning and sometimes for drinking water. By the late 18th and early 19th centuries, during the industrial revolution, rivers in most European countries, as well as North America, had already been severely destroyed. The industries were linked with the main cause of **point-source pollution**. Local residents' garbage and wastewater were collected by any nearby stream in urban areas and towns. However, within that time, the local people still had finite water supplies, restricting excessive use of water.

In the beginning of the late nineteenth and early twentieth century, wastewater volumes expanded dramatically as the need for more advanced and extensive water management grew along with the fast-expanding urban population. This results in a

change in the public's attitude towards funding the construction and maintenance of sewer systems. Urban drainage systems were seen as to be an indicator of civilization. Consequently, central water pipelines and modern sewer systems were started to be constructed to serve households. In large cities across Europe and the US, municipal leaders have launched massive projects to build a comprehensive sewer system. This shift in public opinion was mostly linked to sanitary waste and the spread of disease outbreaks in addition to the mitigation of flood control (Haidvogl, 2018; Kondolf & Pinto, 2017; Burian & Edwards, 2002).

After industrial cities development, there has been a great expansion in urban areas with the centralized sewers and there was increasing demand for clean drinking water. Sanitary cities strived to recover from the destruction caused by industrial cities by applying engineering and management-based solutions in diverse sectors such as transportation, water and health. Although there was an effort to restore, the shift to sanitary cities concurrently altered the focus of large industrials and municipal emissions, referred by Braden & Segerson (1993), to smaller, diffuse sources that lead to non-point source environmental pollution. As a result, urban growth led to a discrete pressure on natural landscapes which are harder to detect and restore. Even though there were efforts to correct these planning mistakes for urban degradation, Booth and Bledsoe (2009, p.111) compare these efforts with small-scale "band-aids," which have little effect on recovering compared to the magnitude of the disruption. Global negative symptoms increasingly emphasize the importance of renaturalizing and environmental watershed regulations.

According to Booth et al. (2016), the stream burial in the cities caused many changes in the land use of the natural landscape. This issue is also commonly referred to as a response across the globe called ''**Urban Stream Syndrome**''. Urban Stream Syndrome refers to degraded ecological conditions on natural streams due to urban developments. Booth et al. (2016) highlight that the extreme diversity of environmental and social factors affecting urban flow around the world results in significant variations in the manifestation of urban flow syndrome. Especially in less

developed countries there are more social constraints that cause them to depend more upon traditional development trajectory in stream management.

Buried streams are not only changing the structure of the river but also the hydrological cycle of the water by building artificial structures eliminating **rainwater infiltration** and natural **groundwater recharge**.

This issue is also addressed as urban runoff which refers to the runoff of rainwater on impermeable surfaces. Thereafter, increasing impermeable surfaces caused increased **infiltration** capacity of the natural streams and increased flow transmission (See Figure 7). As the volume of rainfall-runoff increases, the streams have a flashier runoff regime with shorter lag times and higher peak discharges, which leads to floods in cities (Fryirs & Brierley, 2012c).

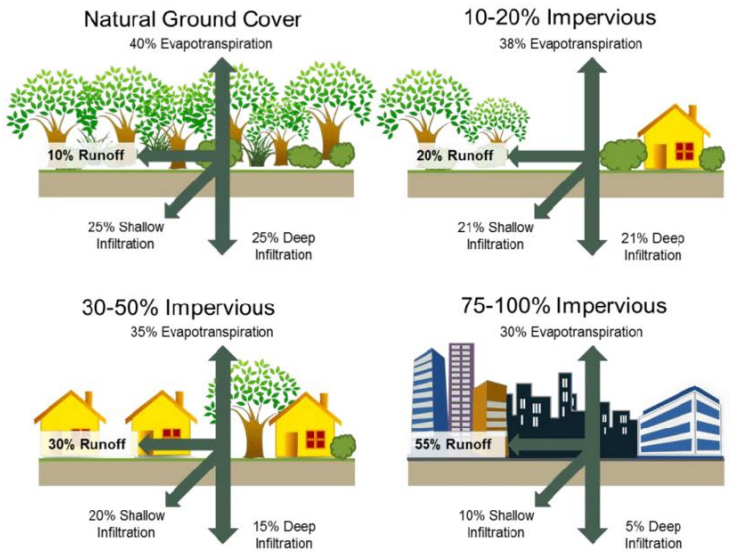

Figure 3.6 Surface cover, imperviousness level and urban runoff

(Source: Holt et al., 2018)

Moreover, a network of buried streams causes the run of combined sewer system where both sewage and stormwater flow through the same pipe system. This results in the sewers becoming overwhelmed (Forgrave, 2022).

3.1.3 Daylighting as a Concept and Practice

According to Khirfan et al. (2020c, p. 10) the definition of stream daylighting is: “the practice of removing streams from buried conditions and exposing them to the Earth's surface in order to directly or indirectly enhance the ecological, economic and/or socio-cultural well-being of a region and its inhabitants”. Stream daylighting is only one of the subsets of emerging disciplines in renaturalization and restoration that have complex steps to achieve (Pinkham, 2001). It is a specific approach and nature-based solution, uncovering buried streams as a part of river restoration.

In order to solve the critical problems related to stream burial such as flash floods and river pollution it is one of the important solutions which involves separating streams from sewer systems. Daylighting helps to slow down the flow of water by reconnecting rainfall to the original soil and rock flow paths of the watershed, thus reducing the potential for large floods downstream. (Forgrave,2022).

The study scales for stream daylighting and river restoration projects can vary, as river restoration usually refers to a larger scale aiming to ecologically enhance full range waterbody systems and includes wide range of activities, treatment types and recovery techniques (Manual of River Restoration Techniques | The RRC, n.d.; Palmer et al., 2014). The practice of stream daylighting is going on since 1970s, overly emphasized in the literature with the Cheonggyecheon Stream project in Seoul (Khirfan et al., 2020a); with the introduction of sustainable water management under the nature-based solutions in urban areas, stream daylighting gains focus.

There is an inconsistency in the definition of stream daylighting in the literature. Especially the case studies mostly lack identifying the treatment types whether the streams channelized or naturalized (Khirfan et al., 2020b). This is because, as grey infrastructure-based solutions seem more economically feasible or the only option, nature-based solutions, and policies are still newly recognized worldwide, and there is still a lack of an environmental and ecological approach. This study prioritize

naturalization solutions, where ecological perspective shapes this study due to conducting answers to climate change crises in the local context.

Furthermore Khirfan et al. (2020a) highlights the importance of the theme of ‘’inclusive planning’’ in stream daylighting literature as there’s a lack of involvement of local stakeholders in stream.

3.1.4 Identifying the Barriers of the Stream Daylighting

There’s a shift in perspective in the practice of river restoration by practioners, scholars and managers. An interdisciplinary approach can give a more complete understanding of the advantages, disadvantages and costs associated with daylighting (Wild et al., 2011; Palmer et al., 2014). Interdisciplinary perspective to conduct the research of the stream daylighting barriers for the Türkiye and local context is highly important as there’s many areas relatedly affecting each other.

About the stream restoration, McMillan & Vidon (2014) emphasize the repeating challenges due to the insufficient monitoring for the project both before-during and after; excessive focus on engineering rather than a broader context, and lack of clearly defined goals with metrics for the success of the stream restoration projects. By the stakeholders there is lack of understanding about the interaction of watershed systems which causes them to implement more visible and popular interventions which may be harmful for the stream environment.

Another barrier emphasized in literature is overcoming social barriers. It is one of the most difficult aspects to address in river restoration. Wantzen et al. (2022)’s study of comparison of European and Asian case studies reveals that the success of the daylighting projects is highly connected with the project coordination between the various stakeholders and getting their support. In addition, Wantzen et al. (2022) indicate, that despite significant local variations, generalizations on the distinctions and similarities between the drivers and challenges in the European and Asian examples of stream daylighting may be drawn.

Perera et al. (2022), in their study of reviewing community involvement in urban waterways governance, specify that literature on this topic reflects there are constraints over the involvement of the community due to risk aversion culture and institutional silo mentalities. Additionally, they note that there is a limited work on well-defined and effective methods to achieve community involvement in urban waterways governance.

In the following chapters, I review the global strategies and case studies of stream daylighting. The case studies will be thematically categorized and reveal the practice of stream daylighting in more detail to support the understanding of the barriers from an interdisciplinary perspective.

3.2 Exploring the Driving Forces, Challenges, and Actions in Stream Daylighting Practices

In the literature review or case study review part, I followed a three-step method (see Figure 3.7). This review is structured on conducting driving forces, challenges faced in the project implementation, actions established for the project implementation, and the lessons learned from the case studies. The objective of this structure is to lead the formulation of the 'Stream Daylighting Barriers' based on case studies.

I reported the following themes in a systematic way, with themes presented alongside illustrative examples from case studies. The review of these cases aims to identify common themes, patterns, and trends across diverse projects and contexts.

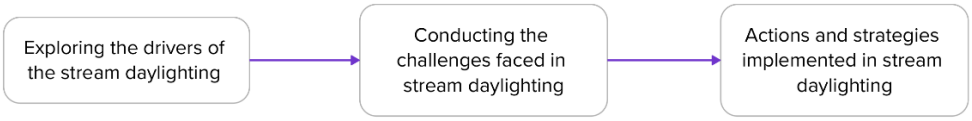

Figure 3.7 Case Study Review Map

(Source: Author's original)

The chapters are divided into the main theme and the sub-themes. Each sub-theme is made by codes which are explained (codes of the articles). Although the daylighting projects encompass site-specific qualities, there are common themes identified that provides a framework for the processes of the daylighting projects.

Table 3.1 Name of the Case Studies and Authors Reviewed

Case Study Number	Geographical Scale	Names of the Cases	Source
1	City Scale	Tibbetts Brook Daylighting, New York, USA	Darby-Cobbs Watershed Partnership, Fairmount Park Commission, Pennsylvania Environmental Council, & Philadelphia Water Department,2009 ; Molnar, 2022 ; Tibbetts Advisory Group, 2022
2	City Scale	The Zurich Stream Daylighting Program, Switzerland	Conradin & Buchli,2004; Wantzen et al., 2022
3	Local Scale	France (includes several cases)	Technicien médiateurs de rivières, 2023; Wantzen et al.,2022; AFB,2018
4	City Scale	Germany, Emscher River Restoration	Wantzen et al. , 2022;Wuppertal Institut für Klima, Umwelt, Energie GmbH, n.d.
5	City Scale	The Godavari River, India	Wantzen et al., 2022
6	National and City Scale	China (includes several cases)	Lin et al. 2019; Rau, 2022; Wantzen et al. ,2022
7	City Scale	Taiwan (includes several cases)	Wantzen et al. ,2022
8	Local Scale	UK (includes several cases)	Wild et al.,2011
9	City Scale	The Cheong Gye Cheon Restoration Project, Cheonggyecheon River, Seoul, KOREA	Lee , 2005; Shin & Lee,2006 ; Seoulsolution ,2014
10	Local Scale	Hastings Creek - Vancouver, Canada	Jin Jingyi, 2016 ; Jones,2001
11	Local Scale	Restoring Streams in Rural Community, USA (Arcadia Creek, Michigan ; Cow Creek, Kansas ; Fox River Restoration Project, Illinois ; Little River Walk Restoration Project, Kentucky ; San Luis Obispo Creek, California)	Buchholz & Younos,2007; Hoobyar,2002
12	City Scale	Darbee Brook, Roscoe, New York, USA	Buchholz & Younos,2007; Pinkham,2000
13	City Scale	Strawberry Creek, Berkeley, USA	MIT, 2012; Pinkham, 2000
14	City Scale	Jolly Creek, Arcata, USA	Buchholz & Younos,2007; Pinkham,2000
15	City Scale	Port Angeles, WA, Valley Creek, USA	Pinkham,2000

Table 3.1 (continued) Name of the Case Studies and Authors Reviewed

16	City Scale	Berkeley, CA: Blackberry Creek, USA	Pinkham,2000
17	City Scale	Urbana, IL,Embarass Creek,USA	Pinkham,2000
18	Local Scale	Urban Creek Daylighting Project:,Wildcat Creek at Davis Park ,CA , USA	Lennon et al. ,2022; MIT, 2012
19	City Scale	Indian Creek, USA	Buchholz et al., 2016

3.2.1 Drivers of Stream Daylighting

In this section, I explore the main objectives or factors that motivate individuals or organizations to initiate stream daylighting. The objectives of the stream daylighting cases address six main thematic themes and 15 themes based on the answers to the question of '*'What are the drivers of the stream daylighting project?'*.

Table 3.2 Drivers of Stream Daylighting Projects

MAIN DRIVERS	Sub-Themes Drivers
1. Environmental Restoration and Protection	Flooding Mitigation
	Ecosystem Revitalization
	Water Quality Improvement and Pollution Reduction
2. Resilient Infrastructure	Upgrading Infrastructure Capacity
	Renewal of Infrastructure
3. Community Engagement and Cultural Identity	Public Awareness and Engagement
	Cultural and Historic Conservation
4. Institutional Initiatives and Policy Support	Transnational Obligatory Agreements
	National Legislative Framework
	Local Action Plan
5. Economic Development	Tackling Economic Decline in Downtown Areas
	Reducing the Unnecessary Infrastructure Cost
	Transforming Abandoned Urban Brownfield Site
6. Public Health and Well-Being	Public Health and Safety
	Social Well-being

3.2.1.1 Environmental Restoration and Protection

‘’Environmental Restoration and Protection’’ explains the common drivers to contributing the sustainable management of water resources, the conservation of ecological integrity and the mitigation of flood risks, aiming ultimately leading to healthier and more resilient ecosystems.

A review of the literature reveals that drivers related to environmental restoration and protection are discussed under four main themes, which include: (i) flood mitigation, (ii) ecosystem revitalization, (iii) pollution reduction and (iv) water quality improvement (See Figure 3.8).

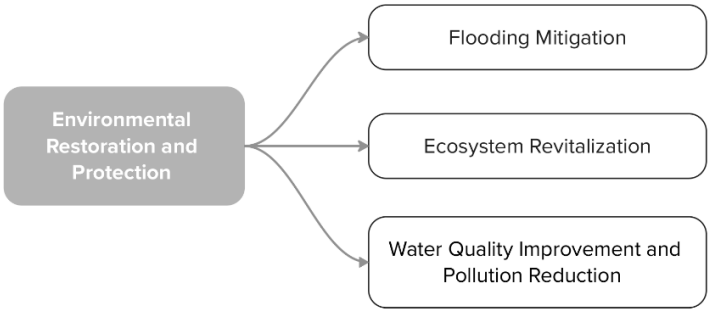

Figure 3.8 Drivers related to environmental restoration and protection

(Source: Author’s original)

‘’Flooding Mitigation’’ emerges as a prominent sub-theme within thematic analysis. The literature reveals the urgency and necessity to address flooding risks, in the context of stream daylighting. Either to defend from the catastrophic flood events, lack of stormwater management system or insufficient infrastructure, the cases pointed out the emphasized the urgent objective for protection from the flooding. For example, in the case of Tibbets Brook Daylighting in New York (Molnar, 2022), the goal was to improve drainage capacity and water retention as part of a broader flood mitigation strategy to reduce combined sewer overflow volume. Buchholz et al.

(2016) also emphasize that the stream daylighting projects are focused on managing stormwater volume in order to prevent flooding in city business centers and residential zones.

The ‘’Ecosystem Revitalization'' theme explains efforts to restore streams as one component among many others. This includes objectives such as improving the ecological quality of the stream and restoring ecological habitats. Ecosystem revitalization efforts elaborate the land and water systems together. To improve the ecological quality of the streams, cases address specific ecological issues affecting their stream refer to aims such as re-establishing fish migration, allowing fish passage, creating water habitats and providing naturalized stream banks (Wantzen, 2022; Pinkham, 2000; Buchholz et al., 2016). In addition some to restore the habitat value of streams the some cases aimed for natural restoration of the river network and creation of riparian corridors (Molnar,2022; Pinkham,2000; Wantzen,2022).

Urban streams are usually polluted by sewage from directly discharged sewage pipes. As a result, buried urban streams can be contaminated with sewage water. Conradin & Buchli (2004) discusses how this effluent water can be treated at wastewater treatment plants and supplied as a source of water for daylighted streams. By ensuring the separation of clean water sources from sewage, wastewater treatment plays a crucial role in stream daylighting projects. This process significantly support the consistent water availability in the streams and helps to water quality maintain ecological balance.

Following this topic, the driver theme of ‘’Water Quality Improvement and Pollution Reduction’’ explains the broader concept of overall motivation to enhance water quality and ecosystem health. Some cases target the reduction of pollutants and contaminants to mitigate their harmful effects on river systems and surrounding environments.

For instance, in the case of Indian Creek USA, the West Branch of Indian Creek was culverted to create new building spaces, and numerous streams were diverted into sewage systems. This led to significant pollution in the Cobbs Creek watershed,

specifically necessitating pollution reduction efforts that became a driving force behind the project (Buchholz et al., 2016).

In the case of Tibbetts Brook, there was severe water quality degradation in the Harlem River. The combined sewer overflowed discharge points as it surpassed the treatment capacity. In response, the NYC Department of Parks and Recreation worked to improve water quality and ecosystem health by implementing green infrastructure to manage stormwater, controlling chemical usage, and removing invasive plants (Molnar, 2022).

3.2.1.2 Resilient Infrastructure

There are several benefits of the daylighting streams as they often increase the capacity to handle stormwater and reduce the likelihood of flooding. In this way, it is possible to restore the natural flow patterns of the streams. Daylighted streams can be integrated into broader stormwater management systems, reducing water runoff on impervious surfaces especially in urban and developed areas.

Responding to this, a review of literature shows that the drivers of resilient infrastructure can be categorized under two sub-themes, namely, (i) upgrading infrastructure capacity and (ii) renewal of infrastructure. (See Figure 3.9)

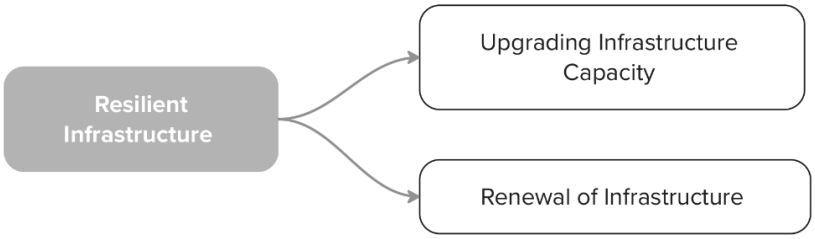

Figure 3.9 Drivers related to Resilient Infrastructure

(Source: Author's original)

A combined sewer system carries both sewage and stormwater runoff in the same set of pipes. During heavy rainfall, the system can overflow, leading to the release of untreated wastewater and stormwater into rivers. A successful natural stream daylighting project consists of the goals of purifying and filtering water separating from sewage and storm water and as a result increasing the drainage capacity.

‘’ Upgrading Infrastructure Capacity’’ theme refers to the aims of the deculverting project as to separate the sewage system from the rain water and improving the infrastructure capacity. Not only to mitigating the flooding risks this also helps to maintain public health and hygiene within the urban areas and improve water quality.

A remarkable example of separating combined sewers is the Zurich Daylighting project. In Zurich, it was discovered that the combined sewer system was causing increased expenses in terms of water treatment. The main technical goal of stream daylighting in Zurich is to implement daylighting to restore the natural pathways of the clean water otherwise carried by combined sewers (Conradin & Buchli, 2004).



Figure 3.10 Cheonggye highway road infrastructure cracks and exfoliation before restoration program

(Source: ICLEI , 2006)

In the Cheong Gye Cheon Restoration Project, the sewer system is a combined system in which waste and rainwater flow at the same pipes. This caused destruction

of the ecological system of the rivers as in the seasons of flooding the highly contaminated rainwater overflows into the Cheong Gye Cheon River. In a motivation to prevent this, larger sewer boxes and twin combined sewer systems were implemented next to the river (Shin & Lee, 2006).

In the case of Bièvre (Seine-Normandie) Deculverting Project in France today, Bièvre serves as a system for rainwater drainage and serves as an alternative for wastewater transportation. With sewer malfunctions Bièvre became an "open-air sewer" due to the growth of urban areas and the establishment of industrial and artisanal activities. 11 km of the river are confined under concrete slabs, while 5 km have been buried under embankments and urban development. The covering of the river continued further upstream of Paris. The daylighting project aimed for separating the stream from the sewage and eliminated the previous asphalt covering the stream (Wantzen et al., 2022; AFB, 2018).

In the case of Tibbets Brook Daylighting, the Tibbetts Brook enters the sewer system unnecessarily, especially in rain events, combined sewage overwhelms the system. Excess water, which treatment plants cannot handle due to the design capacity limits, is discharged untreated into the Harlem River to prevent flooding upstream. This leads to pollution, and releases of gases leading to environmental degradation for local communities. Therefore, leading to the goals of improving drainage capacity and water retention (Molnar,2022).

‘‘Renewal of Infrastructure’’ theme explains the motivation to upgrade the aging infrastructure as it jeopardizes public safety. For example, in the case of Cheong Gye-Cheon Restoration in Korea aging road structures caused both safety and environmental concerns exacerbated by the increased traffic. Since the 1990s, the structure of the covered road and the elevated road has deteriorated (see Figure 3.10), posing a serious safety risk, leading to discussions on the restoration of Cheonggyecheon Stream (Shin & Lee, 2006; Seoulsolution, 2014).

Particularly, the old and inadequate infrastructure in the construction zones lead to safety risks for residents and the infrastructure itself. As cities continue to bury

streams and reduce water retention, a vulnerable and vicious cycle emerges. This can be observed in the example of China's Stream Daylighting and Stream Burial, as discussed by Wantzen et al. (2022). In Wuhan, China many natural streams have been buried or turned into underground drainage pipes due to urban expansion, rapid population growth, and industrial development. This has led to a reduction in water retention spaces and an increase in flooding risks. Influenced by Soviet urban planning approaches, the urban drainage systems in Wuhan were initially designed based on outdated models from the 1950s. These systems often consist of narrow pipes and low conduit coverage, which are insufficient to handle the volume of rainwater during intense rainfall events. As a result, the pipes frequently get blocked, leading to localized flooding and water backups in urban areas.

In many cases, old infrastructure poses challenges during daylighting projects, as unforeseen issues can arise if there is insufficient knowledge about the overall region's infrastructure. Additionally, deteriorating infrastructure may collapse under the strain of storms, as seen in the case of Darbee Brook (Pinkham,2000), which necessitates a daylighting project which is evaluated under the opportunity of the renewal of both the channels and the school grounds above the deteriorating channels.

3.2.1.3 Community Engagement and Cultural Identity

The theme ‘Community Engagement and Cultural Identity’ refers to the objectives of the stream daylighting to raise awareness in public about the local river system, cultural and historical memory preservations, and the aim to enhance public health.

Responding to this, a review of literature shows that the drivers of resilient infrastructure can be categorized under two sub-themes, namely, (i) Public Awareness and Engagement and (ii) Cultural and Historic Conservation (See Figure 3.11).

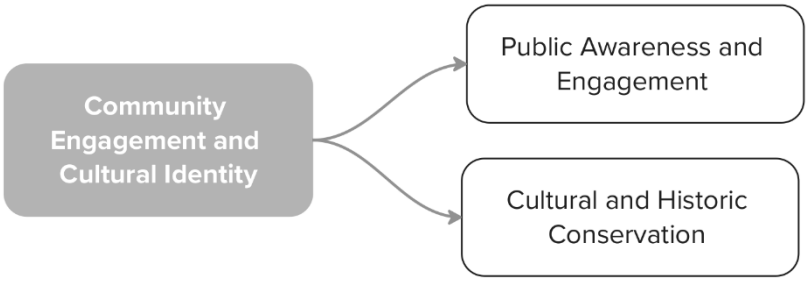

Figure 3.11 Drivers related to Community Engagement and Cultural Identity

(Source: Author's original)

''Public Awareness and Engagement'' is a theme that highlights the drivers related to the public's expectations and pressures related to water resources preservation and deculverting. The citizens and governments active and conscious environmental and water protection motivation can support initiating stream daylighting projects.

The Cheong Gye Cheon Restoration project (Lee, 2005) was led by environmental activists and academics until the Seoul Metropolitan Government initiate an organization to gather information of public opinion for project design. In the case of Zurich Daylighting Project, the national directive of Switzerland took initiative to preserve its water resources, assisted by highly participative political process and direct democracy in the ground of great environmental awareness (Wantzen et al., 2022).

In some cases, initiating daylighting projects through top-down managements requires immense public pressure. For instance, the case of the Godavari River, in India, the river has a great religious value for the locals. However, due to severe pollution and endangering the public health, the river had to be culverted. In response to the gradual disappearance of the Godavari River, environmentalists and citizens to raised their voices and protest for the restoration of their sacred river (Figure 3.12) (Wantzen et. al., 2022; Sailendra,2022).



Figure 3.12 Godavari River activists demanding cleansing of the river in 2022

(Source: Sailendra, K. (2022, December 15). *Solution to Godavari pollution, a pipe dream?* The New Indian Express. https://www.newindianexpress.com/states/andhra-pradesh/2022/Dec/15/solution-to-godavari-pollution-a-pipe-dream-2528716.html)

In the case of one of the first daylighting projects in the United States, transforming an abandoned railway, the city's official landscape architects initially proposed daylighting the stream under the railway. This idea is strongly opposed by the other city's official staff. However, defending that project idea, Strawberry Creek citizens launched campaigns and public meetings to oppose the city officials' implementation of the proposed daylighting project (Pinkham 2000, Strawberry Creek). This movement was particularly effective in evoking a sense of ownership within the locals critical for the viability of the place.

The daylighting project can carry the sub-objectives and motivations to educate the public about the environmental benefits of the streams and natural systems. In the two U.S. case studies from the years of 1990s daylighting served as an opportunity to raise environmental awareness. For example, the schools benefited from the re-designed daylighted stream areas as outdoor classroom providing the school with a living laboratory to enhance the students' ecological understandings and increase their environmental awareness (Pinkham 2000, Blackberry Creek; Pinkham 2000, Jolly Giant Creek).

The theme of ‘’Cultural and Historic Preservation’’ involves the motivations of preserving historical heritages and sites, religious values and traditions around rivers. The daylighting project can consist of motivations showcasing the traditional architecture, preserve and promote historical significance of the region. One example from China is the project of “Historical and Cultural Restoration of the Beijing Yuhe River”. This project aimed for restoring the old waterway and architectural heritage, representing Beijing’s canal culture while daylighting the deculverting the buried streams (Fan and Da, 2018; Wantzen et al.,2022).



Figure 3.13 China - Yuhe River the daylighted section of the stream

(Source: Fan and Da, 2018)

Not only does preserving cultural heritage motivate people, but they also place a high value on the religious significance of their rivers. For instance, the Godavari River exemplifies how some rivers hold deep religious meaning, inspiring public action to

protect them. For many, the value of these rivers extends beyond their economic and transportation functions. Public protests have emerged in response to the loss of river sections and the degradation of sacred pools. To address these issues, restoration efforts have focused on maintaining the river's flow and protecting sacred sites, thereby preserving the river's religious significance (Wantzen et al., 2022).

3.2.1.4 Institutional Initiatives and Policy Support

The theme of ‘’Institutional Initiatives and Policy Support’’ encompasses the legislative and regulatory requirements and integrated planning and management drivers of the stream daylighting projects.

A review of literature presents that the drivers of resilient infrastructure can be categorized under three sub-themes, namely, (i) Transnational Obligatory Agreements and (ii) National Legislative Framework (iii) Local Action Plans (See Figure 3.14).

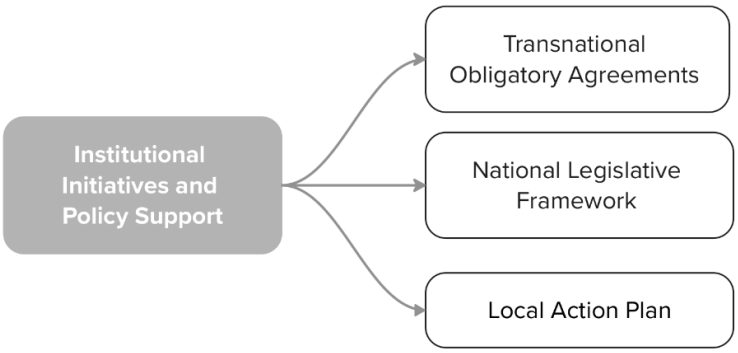

Figure 3.14 Drivers related to Institutional Initiatives and Policy Support

(Source: Author’s original)

‘’ Transnational Obligatory Agreements’’ explains the legislative motivators beyond the national borders to take measures to protect the rivers and hydrological connectivity within the watersheds.

European directives on water (WFD) stands as an international legislative guideline for river restoration which also provides a structure for supporting stream daylighting projects (Wantzen et al., 2022). The European Union established a comprehensive environmental policy consisting of regional strategies and targets to restore rivers and freshwater ecosystems. The Water Framework Directive has served as Europe's main water protection legislation since 2000, applying groundwaters, surface waterways, transitional water, and coastal surface waters. For a transnational cooperation, it ensured that neighboring nations work together to manage the rivers and other bodies of water they share, based on a river basin district strategy (Water Framework Directive - European Commission, 2023).

For example, as Wantzen et al. (2022) cite Gerner et al. (2022) Emscher River Restoration in Germany exemplifies a case that is driven by the European Water Framework Directive which requires the member states to improve the ecological quality of their streams. Between the 1850s and 1900s of Germany's mass population growth and industrialization phase, the Emscher River became the most polluted river in Germany due to the intensive industrial activities that largely destroyed the ecosystem in that area. To manage the wastewater, the river was converted into a concrete canal. By the mid-20th century, efforts shifted towards addressing domestic wastewater and constructing large sewage treatment plants. This project mainly aims to recover the artificial, effluent waterway to its natural state considering the Water Framework Directive requiring reaching good ecological and chemical status in waterways (Wuppertal Institut für Klima, Umwelt, Energie GmbH, n.d.).

The other theme is ‘‘National Legislative Framework’’ referring to the national laws and the stream restoration and daylighting projects, enabling taking water resources and environment under protection and enabling integrated management of stream restoration such as flooding, ecological improvements.

According to the case of Zurich Stream Restoration Wantzen et al. (2022) mentions that the national Swiss water protection legislation, mandated the integration of

stream water with groundwater, as initially discussed by Conradin and Buchli (2004). Therefore, the municipality of Zurich proactively undertake measures beneficial to the environment, initiating its stream restoration and daylighting program.

Another example is from the case French Daylighting projects which the French legislation called ‘’Grenelle’’, France's environment policy including the water law (Wantzen et. al., 2022) This legislation aims to build Green and Blue Infrastructure within France and establish river continuity and restoration. (*European Directive Implementation | River Restoration in France*, n.d.) Also there was a legal pressure of the management and application of river called ‘’River Contracts’’ or ‘’Contrat de Rivière’’ consist of the basin management plans. These plans determine the factors of flood risk reduction, restoration and conversation. River Contracts are not just an environmental preservation contract they also consist of technical and financial agreement between involved partners who are responsible by the same watershed of river (Wantzen et. al., 2022; Définition du contrat de milieu ou de rivière, 2023).

In large-scale cases, government authorities launch integrated regional or national-level projects to carry out river restoration within one hand. For instance, in the case of China, the daylighting projects have been adopted along with the ‘’Sponge City’’ program since 2014 which not only aims for daylighting or stream restoration but also includes urban flood control, water quality improvement, and rainwater harvesting in national level (Rau (2022); Wantzen et al.(2022). Another large-scale program example for the integrated water management program is the ‘’Smart Cities Project’’ by the Government of India. Within the program the Nashik Municipal has deculverted and revived 17 pools (Wantzen et. al., 2022).

The theme of ‘’Local Action Plan’’ outlines the drivers of local legislative initiatives for starting stream daylighting projects. For the city of Zurich, a long-term strategic plan for Zurich also known as ‘’Backonzept’’ included all of the goals of separation of clean external water from wastewater and direct discharge into lakes/rivers, the

opening of previously culverted streams and new stream courses, revitalization of existing unnaturally built open streams, hydraulic relief of the sewer network and treatment plans and cost saving. (Broadhead et al., 2013; Stadt Zürich,n.d.)

To pressure the responsible institutions, it's significant to have common regulations of streams and related natural, infrastructural and social systems that can support both the initiation of the daylighting project and facilitate the practical concerns.

3.2.1.5 Economic Development

The theme of ''Economic Development'' refers to the drivers of the economic effect of daylighting streams. Wild et al. (2011) in their review of 36 daylighting cases around the world underlines that the main drivers for stream daylighting are usually economic. A healthy river ecosystem provides numerous ecosystem services such as water filtering, pollution removal, recreational area creation, and flood reduction. In urban areas, the rivers have direct and indirect use economic value that can be measured within the ES services. The Ecosystem Services framework can be used for practical applications for cost and benefit measurement. (Economics for the Environment Consultancy Ltd (eftec), 2010) Usually, river restoration project interventions bring benefits such as job creation, creating aesthetic value, public recreation spaces, preserving natural lands and increasing tourism.

A review of literature presents that the drivers of ''Economic Development'' for stream daylighting project can be categorized under three sub-themes, namely, (i) Tackling Economic Decline in Downtown Areas, (ii) Reducing the Unnecessary

Infrastructure Cost and (iii) Transforming Abandoned Urban Brownfield Site (See Figure 3.15).

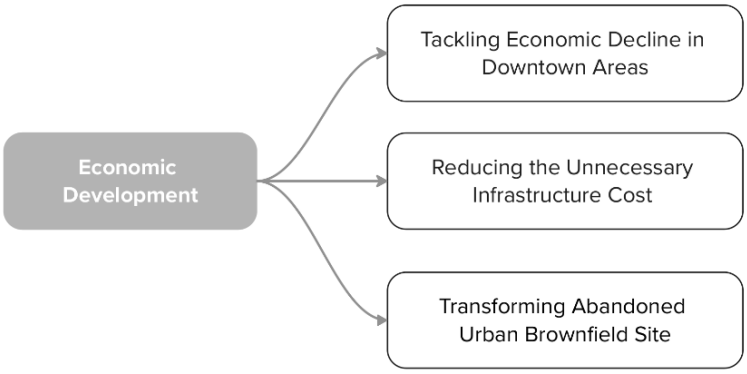

Figure 3.15 Drivers related to Economic Development

(Source: Author's original)

The restoration of Cheong Gye Cheon serves as a compelling example of addressing the first theme of ''Tackling Economic Decline in Downtown Areas''. In the early phases of Korea's modernization, Cheong Gye Cheon River evolve as a vibrant industrial and commercial center. However, as Seoul's economy expanded in the 1980s, the industrial activities in the Cheong Gye Cheon area shifted to the city's outskirts. This resulted in the decline of the surrounding area and the diminishing of the market zone. The successful conclusion of the project has brought about a significant transformation in urban business and planning. Not only changing the surrounding of the stream but also tackling the declining old central business district (CBD) (Shin & Lee, 2006).

The second theme, 'Reducing the Unnecessary Infrastructure Cost'' addresses the motivations to enhance the cost efficiency in the city's infrastructure. In the case of the Zurich Daylighting Program, daylighting the whole city stream was not an arbitrary or ecological driving choice, to make such a huge transformation in the whole city the major driver was to improve the high-cost and inefficient

infrastructure. Zurich is a city surrounded by hills with numerous springs that form over fifty smaller or larger streams flowing into the city. During the last 130 years of the city development of Zurich about 100 km of this previously open water disappeared from the surface. Streams and rivers were channeled into large underground pipes, which eventually became sewers and later they got connected to the sewage treatment plants. As a result, the city's two wastewater treatment plants and the combined system of sewage had to deal with large quantities of "clean" runoff, which increased operational costs and diminished the efficiency of the wastewater treatment process. This situation was found to be creating additional annual costs, which eventually led to a program daylighting length of 19.6 km formerly tubed river stretches (Conradin & Buchli, 2004; Wantzen et al., 2022).

Another case of reducing the unnecessary cost for improving economic efficiency is the Valley Creek Restoration project. In 1997, the Port of Port Angeles and a local lumber mill collaborated to restore an estuary by removing a 150-meter culvert. The aim was to enhance operational efficiencies at the mill. By investing $200,000, the mill reduced annual log transportation costs by $150,000, helping retain 200 jobs and ensuring the Port kept a vital tenant.

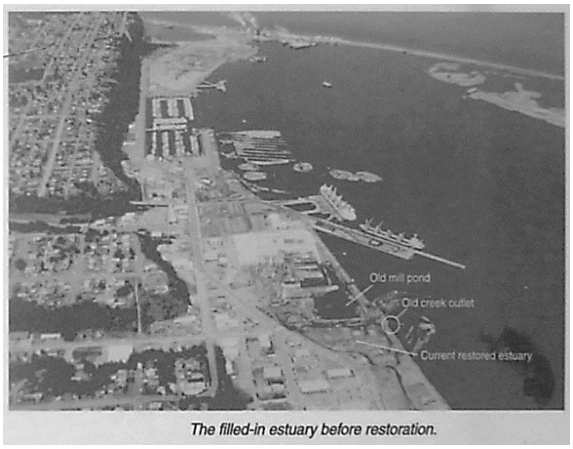

Figure 3.16 The Filled in estuary before restoration in Port Angeles , USA

(Source: Pinkham,2000)

This joint effort showcased how businesses, government, and community groups can turn daylighting projects into economic, environmental, and civic successes. The restored estuary, previously an industrial area, now serves as a popular park attracting tourists and offering improved habitat for diverse wildlife (Pinkham,2000). This transformation emphasized the benefits of daylighting integrating with ecological restoration and economic development in transitioning communities.

The third theme ‘’Transforming Abandoned Urban Brownfield Site’ addresses the drivers of a way of recreational enhancement and economic development in the abandoned areas. Strawberry Creek is one of the first successful examples of daylighting in the U.S. which set a benchmark as a model project. In 1984, an abandoned railyard transformed Strawberry Creek Park. The park now includes playing courts, landscaped hillocks, grassy meadows, native trees, and a brook (Pinkham 2000, Strawberry Creek).



Figure 3.17 The transformation of the abandoned railyard deculverting of the strawberry creek, Berkeley

(Source: First photo (left), Pinkham (2000); second photo (right), MIT (2012).)

The theme of the "Public Health and Well Being’’ refers to the aims of fostering the project area's environmental qualities that impact public health, such as air and water quality, sanitation, safe housing, and overall well-being to access all kinds of public services.

A review of literature presents that the drivers of ‘’Public Health and Well Being’’ for stream daylighting project can be categorized under three sub-themes, namely, (i) Public Health and Safety and (ii) Social Well-Being (See Figure 3.18).

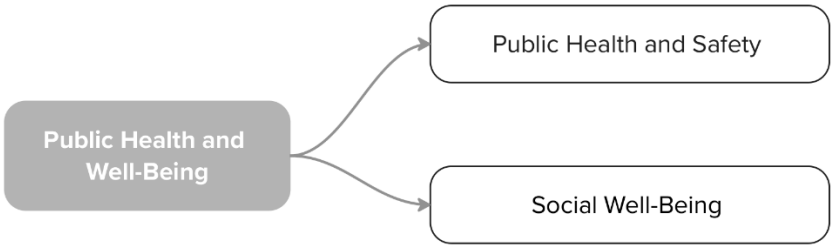

Figure 3.18 Drivers related to Public Health and Well-Being

(Source: Author’s original)

The ‘’ Public Health and Safety’’ theme involves the socio-security goals to provide more balanced, resilient, and attractive urban spaces benefitting the public. This includes creating a more livable environment for the citizens themes include planning goals and motivations in the stream daylighting projects to cope with sanitary, safety, and environmental problems, and improving the conditions of the surrounding streams. As an example, the case of Cheong Gye Cheon Stream Restoration in Seoul (Shin & Lee (2006)) focused on renewing the deteriorated area next to the commercial zone which had problems related to the risk of infrastructural collapse, air pollution, and hygiene issues.

Another example of providing socio-security by daylighting and restoring the stream surrounding as a strategy to revitalize the deteriorating downtown areas, especially in combating rising crimes. Hoobyar's (2002) case studies with medium-sized cities (population 25,000 – 80,000) report that communities facing low commercial occupancy rates in downtown areas have declining property values, diminished economic vitality, and increased crime rates using stream daylighting as a combating strategy.

The second theme, “Social Well-Being’’ driver explains the motivation to increase the recreational facilities within the urban riverscape contributing the public wellbeing. It refers to creating recreation areas such as urban parks or additional improvements such as the creation of jogging and cycling trails, walking trails, landscape and park furniture, pedestrian thoroughfares and educational facilities.

In the early 1900s, Tibbetts Brook was diverted from the lake in Van Cortlandt Park to a combined Broadway sewer. During wet weather, overflow from the Broadway sewer discharges to the Harlem River, which is one of the largest CSO discharge points in NYC. As Molnar (2022) summarized, next to the polluted Tibbetts Brook the neighborhood was reported to have lacks accessible park space and connectivity due to concentrated transportation infrastructure such as highways, elevated train lines causing high levels of pollution and problems in urban health both for the humans and the forest. The community raised their concerns and requested the rehabilitation of the stream and the forest. In response, the NYC Department of Parks and Recreation started rehabilitating the forest by removing invasive vines and restoring playgrounds and other park facilities. Although this helped the urban health and revitalization of Van Cortlandt Park, only after 26 years did the city finally include the daylighting project. So, the public service first prioritized solving the more visible problems such as the lack of accessible parking space problem and improving the deteriorating park then after many years the green infrastructure and its benefits were understood. This is a good example of both increasing recreational amenities and increasing community access and connectivity in a daylighting project as it can serve multiple purposes.

Another example is the Jolly Giant Creek which was daylighted in the 1990s. The creek was highly urbanized, which was both culverted and channelized. Approximately 49 meters of the channel deculverted and 174 meters of surface channel were restored. Once a neglected area, the stream corridor is transformed to a significant pedestrian route and a place for passive recreational areas within the daylighting project (Pinkham,2000).

In the case of Darbee Brook in NYC, below the ground of the Roscoe Central School, a major flooding blew out the decaying culvert. In response, it got funding from the government and support from the locals to partially daylight the stream and improve the area as a new recreational space. Within the restored brook a new educational program to teach about the environment and water science, a new athletic field was constructed, barriers to fish passages were removed and more access to parking spaces for fishing groups was constructed (Pinkham,2000).

3.2.1.6 Most Frequently Observed Drivers in Stream Daylighting Projects

The findings of the content analysis reveal that the most frequently mentioned drivers are, in order of prevalence: "Environmental Restoration and Protection" (40%), "Community Engagement and Cultural Identity" (16%), "Institutional Initiatives and Policy Support" (13%), and "Public Health and Well-Being" (13%).

Table 3.3 Driver Frequency of Mention Table

MAIN DRIVERS	Sub-Themes Drivers Content Groups	sub-themes %	main themes %
Environmental Restoration and Protection	Flooding Mitigation	19%	40%
	Ecosystem Revitalization	12%	
	Water Quality Improvement and Pollution Reduction	9%	
Community Engagement and Cultural Identity	Public Awareness and Engagement	9%	16%
	Cultural and Historic Conservation	7%	
Institutional Initiatives and Policy Support	Transnational Obligatory Agreements	3%	13%
	National Legislative Framework	9%	
	Local Action Plan	1%	
Public Health and Well-Being	Public Health and Safety	4%	13%
	Social Well-being	9%	
Resilient Infrastructure	Upgrading Infrastructure Capacity	6%	9%
	Renewal of Infrastructure	3%	

Table 3.3 (continued) Driver Frequency of Mention Table

Economic Development	Tackling Economic Decline in Downtown Areas	3%	9%
	Reducing the Unnecessary Infrastructure Cost	3%	
	Transforming Abandoned Urban Brownfield Site	3%	
	TOTAL	100%	100%

Under the "Environmental Restoration and Protection" (40%), the most frequently mentioned driver in stream daylighting projects is "Flooding Mitigation" (19%), highlighting mitigating the ongoing flood risks intensified by urban stream burial. The second most frequent sub-theme, "Ecosystem Revitalization" (12%), emphasizes the importance of restoring streams and ecological habitats in the daylighting cases. Thirdly, "Water Quality Improvement and Pollution Reduction" (9%) underscores the role of daylighting projects in reducing pollutants and enhancing water quality in urban areas.

‘’Community Engagement and Cultural Identity (16%)’’ category underscores the importance of fostering public participation and preserving cultural heritage within stream daylighting projects. The relatively high mention of the sub-theme of ‘’Public Awareness and Engagement’’(9%) demonstrate the positive effect of public’s expectations and pressures to initiate stream daylighting projects.

Under "Institutional Initiatives and Policy Support" (13%), legislative and regulatory requirements, along with integrated planning and management, are supporter key drivers of daylighting projects. The sub-theme "National Legislative Framework" (9%) highlights the critical role of national laws in initiating and supporting stream restoration efforts.

For "Public Health and Well-Being" (13%), the focus is on improving environmental qualities that influence public health, such as air and water quality, sanitation, safe housing, and access to public services. Within this theme, "Social Well-Being" (9%)

emphasizes the importance of recreational values and their contribution to enhancing community well-being.

3.2.2 Challenges of Stream Daylighting Processes

''What are the challenges faced with doing the stream daylighting project ?''

This chapter delves into the obstacles and difficulties encountered during the implementation of stream daylighting. A review of literature presents that stream daylighting projects often encounter significant challenges during the planning, design, implementation and post-project phases. Scholars (Buchholz et al., 2016; Hoobyar, 2002; Jones, 2001; Lee, 2004; Molnar, 2022; Pinkham, 2000; Planning and Management Challenges. As seen Wantzen et al., 2022) discussed challenges faced during and after the implementation of ''Stream Daylighting'' in their case study reviews. I found the challenges to establish ''deculverting'' or ''stream daylighting'' are clustered under two main themes: (i) Environmental and Ecological Challenges, (ii) Project in Table 1, two main thematic themes and six subthemes are highlighted in the objectives of the stream daylighting cases.

Table 3.4 Challenges of Daylighting Projects Thematic Analysis

Main Theme	**Sub-Themes**
Environmental and Ecological Challenges	Construction and Flood Management
	Habitat Preservation and Restoration
	Urban Density and Infrastructure Constraints
Project Planning and Management Challenges	Urban Project Management
	Stakeholder Engagement and Collaboration
	Economic Interest Management

3.2.2.1 Environmental and Ecological Challenges

‘’Environmental and Ecological Challenges’’ main theme includes the challenges in stream daylighting process, including issues related to construction, pollution, conservation of natural habitats as well as impacts on streams ecosystems due to urbanization and existing infrastructure.

Under the ‘’Environmental and Ecological Challenges’’ two sub-themes categorized as; (i) Environmental Complications During the Construction and (ii) Urban Density and Infrastructure Constraints.

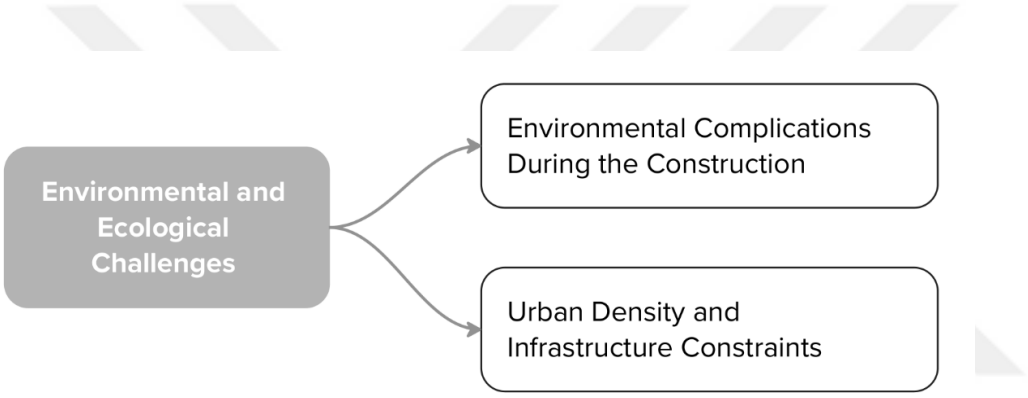

Figure 3.19 The Sub-Themes of Environmental and Ecological Challenges

(Source: Author’s original)

3.2.2.1.1 Environmental Complications During the Construction

‘’Construction and Flooding Management’’ challenges are critical considerations in stream daylighting projects, which aim to restore natural waterways in urban areas. Seasonal flooding, insufficient sewer systems, and outdated drainage infrastructure frequently disrupt construction schedules and complicate project designs. This theme emphasis on **natural environmental factors** (flooding, erosion, and stream meanders) and **technical complications** in deculverting in global cases.

For instance, in Cheong Gye Cheon restoration project, Shin & Lee (2006) reported that the constructions were managed hardly in schedule as the **stream bed floods in the rainy season**. Such natural reasons can further cause technical complications or cause interruption of city life during project implementation. For the Taiwan cases of stream daylighting, it was noted by Wantzen et al. (2022) that there was a **high urban flood risk with an insufficient sewer system** which was the main risks for the establishment of the daylighting projects. Also, urban flooding risk can cause **restraints in construction design**. In the case of Valley Creek (Pinkham 2000), during the construction of an open estuary there were significant concerns of the storm surges. The administrators and designers tried to balance ecological benefits of the water habitat and the practical need for robust protection for the areas exposed to damaging flooding. This confronts the practical implementation of the projects as the flood exposed areas require deeper analysis and studies.

Furthermore, there are habitat preservation and restoration hurdles usually encountered during the project establishment related with the project area landscape and habitat.

One of the disputes faced in this category is the **dominance of invasive species outcompeting native species of the landscape**. For example, in the case of Tibbets Brook Daylighting Project, a tributary of the Harlem River Tibbets Brook was culverted due to the need of land expansion for the growing population in the early twentieth century. With the raise of public concerns and community wide work sessions, NYC Department of Parks and Recreation, started daylighting project as a part of Van Cortlandt Park Master Plan 2034. However, over the ‘’Mill Pond’’ of the brook the DPR reported the condition of low-oxygen environment in wetland complex. The wetland is largely occupied by **invasive species and pollution** which causes deterioration in the ecological function of the area. This was specifically challenging because it can hold a threat to **forest health and ecology** in the area (Molnar, 2022). Including that restoring the wetlands to their original state may take a significant amount of time or even it might not be achievable.

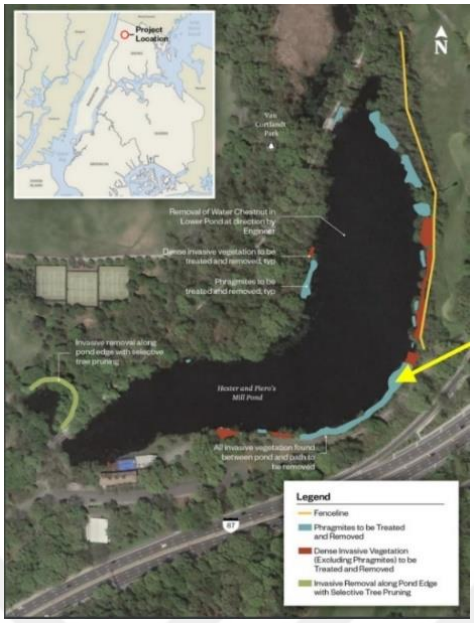

Figure 3.20 Van Cortlandt Lake, Invasive Species Removal eastern and western sides of the lake

(Source: : NYC Environmental Protection. (2022, April 19). *Van Cortlandt Lake improvements and Tibbetts Brook daylighting: Tibbetts Advisory Group meeting #2* [Presentation]. NYC.gov. https://www.nyc.gov/assets/dep/downloads/pdf/whats-new/programs-initiatives/tibbetts-advisory-group-meeting-presentation-2.pdf)

In addition to that DPR (2014) as cited in Molnar (2022) the pollution and lack of accessible park space have **exacerbated health issues** in the neighborhood.

3.2.2.1.2 Urban Density and Infrastructure Constraints

The topic of " Urban Density and Infrastructure Constraints" explains the possible infrastructural hurdles of the daylighting projects, as these can disrupt the entire functioning of a city. There are physical constraints caused by urbanization and insufficent infrastructure, focusing more on **urban infrastructure challenges** and **sewer/drainage system deficiencies.**

When undertaking stream daylighting projects in city centers and urban areas, compared to the rural areas and the city periphery there are additional challenges and increased responsibilities to consider. **Construction on existing infrastructure are**

the challenges faced in the construction area's building on the existing infrastructure particularly during the **demolition of culverts**. For instance, in the case of the Cheong Gye Cheon Restoration project, several notable difficulties emerged. According to Lee (2005) in the project area was located in a downtown zone that included both commercial and residential buildings. There was **traffic congestion** caused by reduced road lanes. The demolition not only caused traffic congestion but also generated significant **noise and dust**. Additionally, there were many large structures that needed to be removed, which **required increased transportation to the area**. Regarding the 27 months of construction, the urban density and existing infrastructure caused extra challenge.

Another crucial challenge for stream daylighting consists of the problems with sewer systems and drainage systems. For example, for the cases of stream daylighting in Taiwan it was noted that the insufficient sewer system with high urban flood risk is a major challenge (Wantzen et. al., 2022). To successfully implement stream daylighting, it is crucial to have a well-functioning sewer system.

There can be several issues involving drainage systems. In the drivers' section, I discussed the motivation to improve the capacity of drainage system. Even if the sewage is treated, it's important to consider the drainage system as it should contain the capacity to manage all of the combined sewer spills as it can cause continuous problems during rainstorms. Similarly, Wantzen et al. (2022) emphasize that in the case of China – Wuhan, **constructing in large and dense urban populations** brings risks which concurrently manage challenges sometimes complicated by flooding risks. Lin et al. (2019) as cited in Wantzen et al. (2022), noting that in Wuhan, the urban drainage systems frequently experienced flooding. This issue arises because of the **existing drainage systems' inadequacies of getting old and incorrectly designed**, relying on narrow-diameter pipes that are not suited to handle heavy rainfall.

Working in an urban area, in the case of Indian Creek Restoration (Buchholz et al., 2016) it was reported that, although the public in Philadelphia wanted further

construction of waterways, the **highly urbanized stream with dense property lines and utilities underground**, **limited the creation of a full natural channel**.

The urban density also can cause restraints in terms of the **historical heritage preservation** in stream daylighting projects. In the case of Germany's Emscher River restoration, sufficient space on the former steel plant site allowed for the creation of a more natural riparian corridor, facilitating ecological development and flood protection. However, the daylighting of the Hörder stream presented different challenges as it took place within an existing housing area, including a castle listed as a historical monument. To address these constraints, a part of the street was removed to create a narrower corridor with bottom windows offering views of the castle's underground sections.(Wantzen et al.,2022)

The natural streams change its natural path and qualities with human intervention. This is an important and controversial factor to consider in daylighting project, whether to change to course of the natural stream as it is already changed or doing a full restoration to restore to its original state. In relation to that in construction design establishing a channel geometry for the new stream channels reported as challenging.

In the case of the Tibbetts Brook Daylighting project, NYC Water (2022), as cited in Molnar (2022), reports that the proposed natural meandering stream corridor couldn’t be established. This was mainly due to the, the **proposed stream corridor becomes very narrow at certain points**, likely due to the surrounding built environment, such as roads, buildings, and other urban infrastructure. This narrowness prevented the construction of a meandering stream, which is characteristic of more natural settings.

In the case of Jolly Giant Creek Daylighting (California, USA) one of the biggest challenges reported in the project was establishing the channel geometry in a floodplain. Due to previous urban development upstream, the creek floods and cause bank full runoff events. The **designers faced difficulties in defining both the bankfull and low-flow channel geometries** and in establishing a new upper floodplain where one did not previously exist (Pinkham 2000). One another hurdle

in restoration faced in the construction area is the **excessive stream bank erosion**. Although it's not a great challenge, it can require replanting vegetation to avert the risk of erosion like applied in the case of Embarass Creek Daylighting (Pinkham, 2000).

Another case refered to **the need of balancing ecological considerations with practical constraints** illustrating the necessity of the tradeoffs to establish daylighting project . Pinkham (2000) describe this phenomenon in the case of Darbee Brook Daylighting, which was culverted in the 1960s to expand Roscoe Central School's playing fields. The culvert caused the fish passage to be blocked and decreased the ecological value of the brook. During the project of Darbee Brook deculvert in the late 1990s, the working group constructed a new channel and diverted Darbee Brook into it, replacing the old culvert with fill to stabilize the athletic field. While establishing it the school's open spaces were sacrificed some flat, open spaces on its grounds to accommodate the brook corridor and revegetate along the Beaverkill River.

3.2.2.2 Project Planning and Management Challenges

This theme encompasses the challenges related to the planning, management, and execution of stream daylighting projects, including decision-making, documentation, communication, urban project management, stakeholder engagement, public acceptance, and financial considerations.

Responding to this, a review of literature shows that the challenges of project planning management can be categorized under three sub-themes, namely, (i) Stakeholder Engagement and Collaboration, (ii) Urban Project Management and (iii) Economic Interest Management.

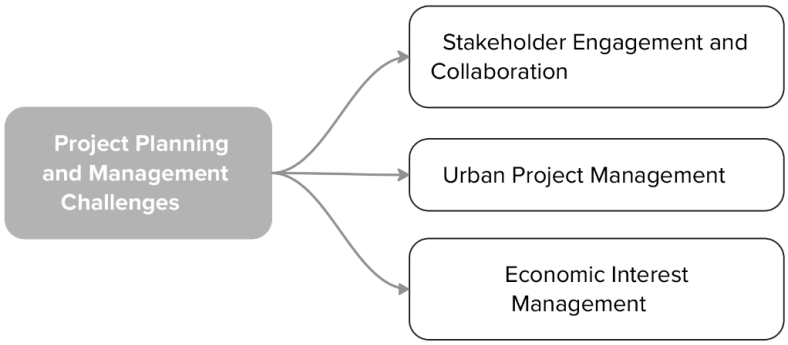

Figure 3.21 Sub-Themes of 'Project Planning and Management Challenges'

(Source: Author's original)

3.2.2.2.1 Stakeholder Engagement and Collaboration

Stakeholder engagement and collaboration represent critical challenges in stream daylighting projects, encompassing difficulties in aligning priorities among administrative actors, fostering public involvement, and overcoming resistance from both local communities and officials.

One of the main observed challenges in stream daylighting is stakeholder management, there are several problems relating to encouraging and motivating the stakeholders of projects, some of which are summarized and exemplified below.

These issues can be either related to the local community or the administrative stakeholders. On the side of the administrative stakeholders, there are various problems identified in relation to the **multi-stakeholder decision making process**.

Wantzen et al. (2022), identified great challenge of the need for efficient communication among project specialists in the case of Zurich Stream Daylighting as many different specialists must work together in a massive infrastructural program. Therefore, a thematic working group called the "Zurich Brook-Team" was created that focused on facilitating interdisciplinary collaboration and communication across scientific, financial, legal, information management, and regulatory domains. However, hired people were from many diverse fields who often encountered each other for the first time which created a **communication challenge**. Also, in the context of daylighting projects in France, Wantzen et al. (2022) observed that not all stakeholders share the same priorities and motivations in project, such as intercommunal syndicates might prioritize environmental advantages whereas municipal entities more concerned with aesthetic and landscaping outcomes.

There are difficulties when multiple actors incorporate in a project in terms of goal alignment. In the case of the ‘’Emscher River Daylighting’’ project in Germany, **conflicts arose during the decision-making** process as there were challenges in reconciling the ecological requirements for natural water systems with the developmental needs for real estate and urban infrastructure (Wantzen et al.,2022).

The Strawberry Creek daylighting project faced significant challenges, primarily stemming from **initial resistance by city officials** who viewed the exposed creek as a potential safety and flood hazard. Officials questioned the necessity of uncovering what they considered a "perfectly good culvert," perceiving the existing infrastructure as adequate. **Overcoming this skepticism** required extensive community mobilization, with advocates organizing public meetings, launching a vigorous leafleting campaign, and rallying citizen support (Pinkham,2000).

On the side of public involvement and motivation, Hoobyar (2002) observed when studying cases of stream restoration in rural U.S. communities that **taking action from the public is challenging**. Hoobyar (2002) implies that when it comes to stream restoration, **the public tends to act only after the condition of the area significantly deteriorates**, which is more visible and obvious.

In another case, the Cheong Gye Cheon Restoration Project, Shin & Lee (2006) indicate the same issue that **encouraging community involvement in daylighting project was challenging**.Consequently, they had to organize intensive public involvement programs, including 4000 meetings with citizens, to encourage participation.

The **locals can resist the project to preserve historical heritage**. In France, Wantzen et al. (2022) exemplified this issue from the case of Sonette. The locals had first opposed the daylighting project in Saint-Laurent-de-Céris as the original plan consisted of demolishing the entire complex because they had a living memory of the former factory.

There is a **public resistance and the recognition-implementation gap** regarding the stream daylighting projects. This issue can cause the continuation of stream burial activities as mentioned by Wantzen et al.(2022) in the cases of Taiwan Daylighting projects. On the contrary, Hoobyar (2002) underscores that even though there is recognition of the value of stream restoration efforts, including daylighting, the actual implementation is limited in the rural area restoration cases of the USA. He reflects on a gap between recognition of environmental benefits and practical barriers to executing such projects while stream daylighting remains relatively uncommon.

3.2.2.2.2 Urban Project Management

The scope of "Urban Project Management" encompasses challenges related to underdeveloped project designs and the ongoing maintenance of projects.

One significant issue in urban project management is the constraints of time, funding, and site availability associated with daylighting projects, which often **limit comprehensive project development**. For example, in the case of the Darbe Brook Daylighting project, Pinkham (2000) noted that the project group was unable to

conduct extensive geomorphic analysis on the project area. Instead, the design mainly relied on a few channels with measurements typically representing the stream above the culvert.

Dealing with the past poor planning decisions was also reported as a challenge that can continue for many years, causing ecological degradation and infrastructural hurdles in restoring the stream. In the case of Tibbetts Brook Daylighting, Molnar (2022) mentions that **the past planning decisions**, the development of roadways coupled with elevated train lines and large residential complexes resulted in a segregated neighborhood and inaccessible park. This situation was exacerbated by the low quality of water and the threat of health issues of the sewer spilled stream. It caused more complicated a phased and calculated plans to reverting the previous mistakes.

Another problem in urban management illustrated is the several **projects overlap and develop at the same time interrupting each other**. This was summarized by Guo, 2018, as cited in Watzen et al., 2022, in the case of the Big East Lake water network project which aims for the hydrological connectivity between the Yangtze River and the city lakes. Altough the government supports the projects to restore hydrological connectivity, several projects overlap and develop at the same time interrupting each other and new open drainage channels were built unrelated to previously existing rivers and streams. This complicated the priorities for daylighting or restoring efforts.

Once a daylighting project is completed, addressing maintenance issues becomes crucial to ensuring its long-term effectiveness. **Maintenance challenges** include post-construction problems such as social issues (e.g., vandalism, graffiti, damage to plants, signs, and fences), changes to stream features, and difficulties in the recovery of habitats in the project area (Pinkham 2000; Wild et al. 2011).

Wild et al. (2011) emphasizes the importance of monitoring because, in some UK daylighting cases, there is insufficient evidence to demonstrate the ecological benefits. Wild et al. (2011) outlines that the success of the project depends on factors

beyond the removal of culverts alone. To effectively meet the ecological improvement goals of the projects, it is essential to report where the real benefits have been achieved, rather than combining different impact results and making broader statements. Furthermore, **the lack of dissemination of the project and the project results** can hinder the community recognition and adoption of daylighting initiatives. This gap in public awareness can significantly restrain the progress of daylighting projects. Hoobyar (2002) has noted that, based on the project's rural areas in the USA, there has been difficulty in measuring the project results as there was a lack of previous state and the after projects. He also mentioned that the city officials regretted not documenting the project's evolution more effectively.

3.2.2.2.3 Economic Interest Management

‘’Economic Interest Management’’ theme addresses the challenging economic complaints that emerges in the daylighting stream projects. The funding and cost management of stream daylighting projects vary across different countries due to local economic, social, and cultural factors. In terms of economic interest, it is important to note that such major restoration projects can come with a social cost. River restoration brings new economic values such as recreational, cultural, agricultural or tourist, defining potential new economic values which is critical for the decision makers and project stakeholders.

Furthermore, when evaluated by the public, the daylighting project can benefit with regulation and cultural ecological services or can cause negative extra costs to each household which can determine citizens’ willingness to pay or support the project (Bae, 2016).

The possibility of initiating the daylighting project largely rests on the knowledge of finding the funding for the project so as these case studies are successfully initiated projects, the funding acquisition problems refer to problems in two areas, first is the process of finding funding for the projects and the second problem is providing after-

project maintenance funding. **Funding allocation and acquisition** can be a problem as the institutions may have different priorities in terms of investing their budget.

Chou (2016, as cited in Wantzen et al., 2022) highlights that, in the case of Taiwan daylighting projects, the cost of building water treatment plants and interceptors is enormous. The majority of the funding is spent on sewage and water treatment, limiting the funding for other parts and benefits of the daylighting projects. This causes more cost for the restoration of the rivers, especially for some of the global south countries.

Another issue discussed by Molnar (2022) comments on her concerns over funding allocation for the project for maintenance in the project for the Tibbets Brook Daylighting. According to her review, due to **the overlapping agency responsibilities** and considering both two major responsible stakeholders are underfunded, there are **complications over the maintenance cost for landscape cost and the technical engineering costs**.

Hoobyar (2006) discusses the issue of **funding acquisition**, in the San Luis Obispo Creek Daylighting which is a case the community chose not to completely bury the stream under parking lots, downtown buildings, and streets. Stream restoration efforts initially didn't find any financial support from the downtown merchants as they were worried about flooding, losing parking space, traffic, and accessibility. This was addressed when a citizens' committee was formed, the committee studied a project proposal to find a common solution addressing these issues and daylighting the creek.

Another challenge, this explains the concerns of the stakeholders about the project's financial viability and economic loss caused due to construction of the project. According to Wantzen et al. (2022), citing Gerner et al. (2022),the Emscher basin in North-Rhine Westphalia, Germany, underwent significant environmental restoration from 1990 to 2021, with an investment over €5.6 billion to replace an open sewer system with a modern underground sewage network and to daylight previously buried streams such as Hoesch Kanal and Hölder Bach. Initially, stakeholders

expressed concerns about the costs and complexity of the restoration project which almost compromised the financial viability of the project. To prevent this the Emschergenossenschaft has organized guided tours and showcases to demonstrate the project's progression, effectively illustrating its potential success and alleviating worries about costs and complexity. This underscores the importance of **engaging and persuading the responsible stakeholders to achieve a stable financial base for daylighting projects**.

A similar problem of situation but on a local scale is described by Pinkham (2000) in the case of the Strawberry Creek daylighting project. In the project, a teacher sought a grant to provide the creek with signage that would increase the streams visibility. However, **the funders had concerns over financial viability** regarding interpretive signage revolve around costliness, perceived vulnerability to vandalism, and the need for innovative funding strategies to support educational enhancements for the creek area.

Another reason according to the stakeholders funding allocation is the **high costs of the projects** specially the stream daylighting projects is **the ownership of the area and property values**. Hoobyar (2002) highlights that in the USA most of the daylighting stream projects can take place in large metropolitan cities due to the functions of the economics. He states that it can be highly costly to purchase a town center real estate or move the commercial components as a built infrastructure, including the need for an engineer to meet the parameters of the flood control, habitat needs, and the city's amenity needs. Since it is highly costly, Hoobyar (2002) points out that the **smaller communities may have difficulty in compensating for the costs** which may require finding different funding mechanisms. However, in lieu, as Wantzen et al. (2022) cite Khirfan et al. (2020c); stream restoration projects are much more costly in urban areas compared to rural lands. Also, as urban land ownership is usually more fragmented (Wild et al., 2019), it is easier to implement the stream daylighting project into the available open spaces such as urban parks.

Lastly, daylighting projects often require a long construction, particularly in the city centers, that can greatly impact the surrounding areas. It can cause the challenge of **economic loss due to construction work** in the daylighting project area. In the Cheong Gye Cheon Restoration Project, the adjacent business areas for the same reason had an economic loss. In response to that, the Seoul Government facilitate the relocation of commercial districts and implemented measures to create business stability (Lee,2005; Shin & Lee,2006).

3.2.2.3 Most Frequently Observed Challenges in Stream Daylighting Case Studies

Table 3.5 Stream Daylighting Case Studies Challenges Frequency of Mention Analysis

Main Theme	Sub-Themes	Sub-Themes %
Project Planning and Management Challenges	Stakeholder Engagement and Collaboration	34.0%
	Urban Project Management	17.0%
	Economic Interest Management	17.0%
Environmental and Ecological Challenges	Urban Density and Infrastructure Constraints	18.9%
	Environmental Complications During the Construction	13.2%

‘’Project Planning and Management Challenges’’covers the organizational and socio-economic aspects of daylighting projects. The sub-themes include:

- **Stakeholder Engagement and Collaboration (34.0%)**: As the most frequently mentioned sub-theme, it underscores the critical challenge of

involving stakeholders, participatory processes and gaining public support in daylighting projects.

- **Urban Project Management (17.0%)**: This sub-theme indicates challenges such as coordinating with various agencies and managing project timelines. Its frequency shows it is a moderately significant concern.
- **Economic Interest Management (17.0%)**: Suggests that economic constraints are as critical as urban project management issues, this theme summarizes the challenges in financial constraints, such as funding and allocation and acquisition.

''Environmental and Ecological Challenges'' highlights the environmental and built-environment constraints faced during stream daylighting projects. The sub-themes under this category and their respective frequencies are:

- **Urban Density and Infrastructure Constraints (18.9%)**: Having a slightly higher frequency, this challenge indicates the significance of urban planning issues such as space limitations and pre-existing infrastructure conflicts. Particularly reflecting the difficulty of implementing daylighting in dense urban settings.
- **Environmental Complications During Construction (13.2%)**: Although it is not the most dominant concern, this sub-theme reflects challenges associated with natural environmental and technical complications, especially regarding flooding risks.

3.2.3 Actions Implemented in Stream Daylighting Projects

This section focuses on the actions, interventions, and strategies used in the case studies in response to the established driving forces and to overcome challenges based on the question of *''What are the actions established in stream daylighting projects?''*.

Out of 19 cases 18 cases referred to actions and strategies implemented for stream daylighting. A review of literature presents that the actions to establish ''deculverting'' or ''stream daylighting'' are divided into five categories, namely: (i) Stakeholder Involvement (ii) Infrastructure Development, (iii) Project Planning and Management, (iv) Environmental Restoration and (v) Policies and Legislative Regulations. Seven main thematic themes and thirteen subthemes are highlighted in the objectives of the stream daylighting cases.

Table 3.6 Actions of Stream Daylighting Projects based on Thematic Analysis

MAIN THEME	SUB THEMES
Stakeholder Involvement	Active Engagement of Public
	Educating Public about Project
	Collaboration of Different Authorities
Infrastructure Development	Accessibility and Connectivity Enhancements
	Water Management Systems
	Recreational and Aesthetic Improvements
	Structural and Engineering Works
	Safety and Nighttime Appeal
Project Planning and Management	Development of Integrated Urban Plans
	Establishing Project Monitoring and Assessment
	Land Management

Table 3.6 (continued) Actions of Stream Daylighting Projects based on Thematic Analysis

Environmental Restoration	Stream Restoration and Modification
	Enhancing Landscape Elements
Policies and Legislative Regulations	Legal and Governmental Support

It is important to note that geographical conditions, project context, challenges, and project objectives are unique to each project area. Therefore, this chapter serves not as an index for the daylighting project actions but a road map for the tailored Ankara case study to be compared and discussed with the results of the in-depth interview.

3.2.3.1 Stakeholder Involvement

The ‘’Stakeholder Involvement’’ refers up to the strategies in the solutions for building consensus between the different groups through creative and effective methods. The frequency of mentions of ‘’Stakeholder Involvement’’ in the actions of stream daylighting case studies suggests that it is a central issue for resolving the challenges and effectively implementing the projects.

A review of literature presents that the actions of ‘’ Stakeholder Involvement’’ for stream daylighting case studies can be categorized under four sub-themes, namely, (i) Active Engagement of Public, (ii) Education of the Public and (iii) Collaboration of Different Authorities.

3.2.3.1.1 Active Engagement of Public

The ‘’Active Engagement of the Public’’ highlight the potency of public engagement and participatory processes especially for the environmental projects. It focuses on

direct involvement of the public in decision-making processes, planning, or even hands-on project activities.

In the cases of the project consist of public compromises to reach a balanced outcome between the planners and the locals. For instance, in the case of Sonnette River Restoration the original plan was aiming to demolish the entire local heritage. However, through public debates, a middle-ground solution was reached about maintaining the old washhouse and repurposing it, rather than demolishing the entire complex (Wantzen et al., 2022).

In the case of Emsher River Restoration the 'Emschergenossenschaf', organized guided tours were used to explain the project's development, which actively informed and engaged the public and stakeholders. The process influenced stakeholders' views by showcasing the benefits and feasibility of the project, encouraging acceptance and collaboration. In addition, the water board ensured public participation through formal and informal meetings, which helps to solve the conflicts within the project cycle (Wantzen et al., 2022).

The cases also highlight the role of volunteers in hands-on restoration and maintenance activities. In the cases of both Jolly Creek Restoration and the Darbee Brook Restoration; Pinkham (2000) highlights the active participation of students and community volunteers in significant restoration tasks, such as planting and maintenance. In Jolly Creek Restoration students were involved in assessment and monitoring, contributing to skill-building and environmental stewardship. While in Darbee Brook Restoration, the collaboration of the students and volunteers extended to infrastructure creation (e.g., the footbridge) and ongoing maintenance, integrating community groups like local fishing organizations

The local community formation also helped to achieve the goals for stream daylighting. Stadt Zürich (2020), as cited in Wantzen et al. (2022), describe the Zürich Stream Daylighting Project, garden owners offered private spaces to integrate with the project. In addition, stating that neighborhood associations ('Quartiervereine') engaged residents, created spaces for urban waters in parks and

public buildings, and acted as an intermediary between citizens and local authorities.

Similarly, as Molnar (2022) noted in the case of Tibbetts Brook Daylighting in NY, a coalition of local organizations, community groups, and public officials formed in 2016 to support the project. This further demonstrates how collective action, and collaboration can drive successful stream daylighting projects.

In the case of Blackberry Creek Restoration, Pinkham (2000) noted that the public was actively engaged, and collaboration between project designers and community members was evident. During the examination of the project area, the project managers directed many questions to the public to analyze the risks of the stream area.

3.2.3.1.2 Educating the Public about Project

Educating the public about stream restoration projects was crucial for generating support and involvement. The case studies describe various approaches in the stream daylighting project used to raise awareness and involve the community such as hosting local arts-themed programs, establishing educational centers to showcase project outcomes, and engaging students.

In the case of Jolly Creek, USA Restoration, the gap of human resources filled with students and neighborhood volunteer labor for all restoration process expanding from, design, to monitoring (Pinkham 2000). This enabled the educational and stewardship benefits of engaging students in hands-on restoration and maintenance activities to foster a deeper connection with nature from young age.

In the case of Blackberry Creek Daylighting, Berkeley,California, USA, it was aimed to deculvert a stream underneath a schoolyard in 1995 (Pinkham,2000). The project was inspiring in terms of community engagement, interdisciplinary collaboration, and workforce development. Local residents provided valuable historical and observational insights, enhancing technical design. While the labor crew was

composed of low-income and minority young adults gaining job training under expert supervision. Additionally, the project team informed the neighborhood about the benefits of the project and relieved the common concerns of the people regarding safety and appearance. This has not only contributed to the environmental restoration goals but also enabled social impact, fostering skills development and community involvement. Similarly, in the case of Strawberry Creek Restoration, the parks department staff initiated an innovative program, a local job-training program to maintain the facility of the restoration program which trains and makes high school students from low-income families work especially to maintain the park (Pinkham,2000).

Another inspirational case for educating the public is the ‘Darbee Brook Restoration’’ program, a case of restoring a deteriorating culvert on the grounds of a primary school. After the New York Department of Environmental Conservation completed the restoration of the brook, the school incorporated the stream into its educational curriculum. Students learned about local brooks and rivers, including aquatic insects, streamside shade trees, and how trout contribute to the tourism and fishing-based economy of the local area (Pinkham, 2000).



Figure 3.22 A community embroidery artist project created with over 100 volunteers representing imaginary mapping of Tibbetts Estuary

(Source: Tibbetts Estuary Tapestry. (n.d.). City as Living Laboratory (CALL). Retrieved December 20, 2024, from https://www.cityaslivinglab.org/rescuing-tibbetts/tapestry)

In the case of Tibbetts Brook Restoration, City As Living Laboratory (CALL) organized various art-theme programs to raise awareness with the local community (Molnar,2022). The creative programs of CALL included digital audiobooks, art-making sessions, community film-making, and interactive mapping, which were developed with many public workshops (CALL,n.d.).

According to Huang (2018) as cited in Wanzten et al. (2022), one of the most successful daylighting projects in Taiwan is the Laojie Stream Daylighting Project. This initiative includes the Laojie Stream Education Center, which features river-themed displays. The center showcases the history of the river and offers interactive activities related to the daylighting project, such as guided tours, models, and films that demonstrate the successful outcomes of the deculverting project (Wanzten et al., 2022).



Figure 3.23 Laojie River Education Center, Taoyuan, Taiwan

(Source: Laojie River Education Center (老街溪河川教育中心). (n.d.). Taoyuan Tourism. Retrieved December 20, 2024, from https://travel.tycg.gov.tw/en/travel/attraction/662)

3.2.3.1.3 Collaboration of Different Authorities

‘’Collaboration of Different Authorities’’ sub-theme explains the actions in daylighting project through collaborative efforts among various stakeholders, establishing open public meetings and the collaboration between interdepartmental

tasks. The cases demonstrate how multi-level stakeholder collaboration and engagement can provide resistance and foster consensus for ambitious projects.

For the success of a deculverting project, the cases indicate the importance of the involvement of various stakeholders for stream restoration. In the case of, Godavari River Restoration in Nashik city, the daylighting efforts were more successful, with a priest and founder of an NGO filing a public interest litigation with the Bombay High Court to de-concretize and restore the Godavari River to its original state, which directed the Nashik Municipal Corporation to take necessary steps (Wantzen et al., 2022). This underscores the importance of daylighting projects that can benefit from social movements and bottom-up political engagement, especially when supported by existing NGOs.

In the case of Hasting Creek Daylighting, in Vancouver, a working committee composed of representatives from the community, government, and businesses collaborated on a design for a park, and various community groups were involved in a project funded jointly by the City of Vancouver and the Pacific Racing Association supporting the representation from each group (Jones,2001).

Establishing open and collaborative meetings with stakeholders that are accessible to the public and enable transparency in several case studies were highlighted, such as in the case of the Fox River Restoration Project, USA, Hoobyar (2002) which is a case of rural city restoring the downtown commercial area. The downtown was suffering from unsafety and the buildings were deteriorating, although the public demonstrated disinterest in their downtown revitalization. The restoration organizers contacted various community organizations early on to generate awareness and interest, ensuring inclusivity by involving local service groups and government officials on the project's board. Assisted with regular public meetings, facilitated discussions, and a clear mission statement further encouraged participation, while partnerships between the Planning Commission, Downtown Association, and Park District helped drive the project. In the meetings, it was ensured that the stakeholders understood the stream restoration concept and supported the revitalization. In

addition, the organizers capitalized on the community's existing desires to raise local issues and increase the support for the revitalization.

There should be a collaboration between the interdepartmental tasks to complement the needs of a comprehensive water management project. In the case of the Zurich Daylighting project, Wantzen et al. (2022) referenced Stadt Zürich (1993), which highlighted that the recreational areas construction, urban development, flood management systems, and several on, assisted five municipal departments worked together on interdepartmental tasks such as establishing ecological guidelines, managing maintenance responsibilities, and developing spatial planning principles

Successful daylighting efforts often require extensive stakeholder engagement, including open meetings and public involvement to gather diverse input. Involvement of NGOs and community groups as intermediaries is vital, as is collaboration between municipal departments and organizations for effective project implementation.

3.2.3.2 Infrastructure Development

Infrastructure development can be understood through interconnected sub-themes, including (i) accessibility and connectivity enhancements, (ii) water management (iii) recreational and aesthetic improvements, (vi) structural and engineering works and (v) safety and nighttime appeal.

3.2.3.2.1 Accessibility and Connectivity Enhancements

The deculverting case study projects focus on enhancing recreational opportunities by investing in infrastructure to increase connectivity and accessibility. This includes maintaining access by reconstructing pathways and building pedestrian walkways and bridges.

In the Tibbetts Brook restoration project in New York, the plan aimed to increase the usability and appeal of park spaces surrounding the brook. Pathways and pedestrian bridges were reconstructed throughout the park to enhance accessibility and create a unified design. These enhancements not only improve the look and feel of the park but also address accessibility concerns, reinforcing the importance of spatial connectivity in revitalized green spaces (Molnar, 2022).

3.2.3.2.2 Water Management Systems

Stream daylighting projects often include infrastructural enhancements to manage water resources effectively, such as water supply management, creation of stormwater management features, and separating combined sewers The case projects integrate water supply management by addressing the separation of surface water from sewage, which prevents contamination and enhances water quality. As Lee (2005) explained in the case of the Cheong Gye Cheon Restoration project, the project involved supplying water to maintain the river; from the Han River which is 15 km far away from the stream, and groundwater taken from subway tunnels was supplied daily. The supplied water is discharged at five locations as the forms in waterfalls. In addition to the water supply system, there are sewer containers to mitigate flooding.

3.2.3.2.3 Recreational and Aesthetic Improvements

In the Fox River revitalization project in St. Charles, the replacement of a structurally unsafe bridge included pedestrian walkways, benches, and decorative lighting to enhance safety and aesthetics (Hoobyar, 2002).



Figure 3.24 Fox River Restoration St. Charles

(Source: *River Corridor Foundation of St. Charles*. (n.d.). Retrieved December 4, 2024, from https://www.stcrivercorridor.org/)

The new bridge design unified the downtown area, integrating it with a historic hotel restored as an economic and cultural center for the region. The aesthetic upgrades and improved accessibility boosted pedestrian accessibility, revitalized the downtown core, and attracted pedestrian-friendly businesses such as art galleries and restaurants.The cases also include actions like expanding trails, such as cycle paths, and the development of foot and bike paths within parks.

3.2.3.2.4 Structural and Engineering Works

This sub-theme includes key actions such as river channel widening, construction of bridges to maintain traffic flow, channel stabilization and erosion control, and channel morphology adjustments.



Figure 3.25 A pedestrian bridge construction in Cheonggyecheon stream project

(Source: Lee, 2005)

The restoration of the Cheonggyecheon stream project, after demolishing the long roadway and deculverting the waterway, raised concerns about disrupting connectivity between the two sides of the stream. To address this, a total of 22 bridges—both for vehicles and pedestrians—were constructed across intersections and crossings. These bridges ensured seamless traffic flow while integrating the restored stream into the cityscape. In addition, one bridge, buried for decades, was also restored to preserve its historical significance (Shin & Lee, 2006).

3.2.3.2.5 Safety and Nighttime Appeal

To increase safety measures along the stream, the Cheonggyecheon stream restoration project in Seoul integrated strategic lighting to enhance its nighttime appeal. Accented lighting highlighted downtown areas such as Cheonggye Plaza, adding to the city's aesthetic charm and promoting nighttime activities. Meanwhile, minimal lighting in certain areas protected the ecological system, demonstrating a balance between urban and environmental considerations. The lighting design incorporated waterproof and indirect lighting, creating a visually appealing and safe environment for residents and visitors. This strategic lighting emphasized the significance of nighttime activities in enriching urban vitality along the deculverted stream (Shin & Lee, 2006).



Figure 3.26 Cheonggyecheon Stream Lightinging at Night

(Source: *Cheonggyecheon Stream—All You Need to Know BEFORE You Go (2024)*. (n.d.). Tripadvisor. Retrieved December 22, 2024, from https://www.tripadvisor.com/Attraction_Review-g294197-d1046419-Reviews-Cheonggyecheon_Stream-Seoul.html)

3.2.3.3 Project Planning and Management

The “Project Planning and Management’’ theme identifies the actions of combining the restoration goals to urban plans and the monitoring and maintenance efforts to sustain the project area.

A review of literature presents that the actions of ‘’Project Planning and Management’’ for stream daylighting project can be categorized under three sub-themes, namely, (i) Development of Integrated Urban Plans and (ii) Establishing Project Monitoring and Assessment and (iii) Land Management.

3.2.3.3.1.1 Development of Integrated Urban Plans

‘’Development of Integrated Urban Plans‘’ sub-theme explains the significance of combining ecological, infrastructural, and socio-economic goals of stream daylighting within integrated urban plans. Stream daylighting projects exemplify the integration of ecological restoration into urban planning, addressing diverse challenges and goals through detailed spatial planning.

The San Francisco Estuary Institute's Wildcat Creek study pioneered watershed-level analysis, integrating scientific research into land-use planning (Lennon,2022). Meanwhile Hoobyar (2002) emphasized San Luis Obispo achieved cost-effective planning by involving graduate students in creating a master plan, showcasing academic-community synergy. The New York's Tibbetts Brook Daylighting project, became part of the Van Cortlandt Park Master Plan 2034, supported by a detailed conceptual plan using interdisciplinary data (Molnar,2022).

On the other hand, Embarass Creek saw limited neighborhood involvement due to low population density but included daylighting within the park's master plan, emphasizing urban ecological restoration (Pinkham,2000). The Indian Creek Daylighting Project integrated into the Green City, Clean Waters initiative, aligning

ecological goals with urban water management within a congressionally funded framework (Buchholz et al.,2016).

As Wantzen et al. (2022) as cited in General Office of the State Council (2015) in China's Sponge City Program expanded the scope of stream daylighting to address urban biodiversity, flood control, and city-wide sustainability, initiating large-scale projects. These efforts highlight how integrated large scale programs and master plans including stream daylighting can fulfill multiple urban planning objectives.

3.2.3.3.2 Establishing Project Monitoring and Assessment

" Establishing Project Monitoring and Assessment'' sub-theme describes establishing robust monitoring and assessment frameworks to ensure the long-term success of the project area. In Zurich, Loritz et al.(2016) mention that maintenance plans were integrated early in project planning, with regular updates to document changes over time, enabling sustained management and adaptability.

Sometimes the project area requires close hands-on management. In the Embarrass Creek project in the United States, park workers actively monitored the ecosystem, addressing challenges such as beaver dam construction by installing pipes to regulate water flow, wrapping valuable tree trunks with wire mesh, and closely observing beaver activities (Pinkham, 2000).

Wantzen et al.(2022) emphasized the role of The French Biodiversity Office (OFB) playing a pivotal role by monitoring restoration projects in the France daylighting projects, offering guidance, and maintaining a database of case studies to inform best practices and support ongoing initiatives. Today in addition to monitoring The French Biodiversity Office created a database of stream daylighting cases.

These examples demonstrate how integrating proactive monitoring and adaptive management contributing to the sustainability and effectiveness of stream daylighting projects.

3.2.3.3.3 Land Management

Land-owning strategies, such as leveraging existing land resources, targeting affordable zones, or integrating with cultural heritage projects, can facilitate effective project planning and management in stream daylighting initiatives.

In the case of the Zurich Daylighting project, Wantzen et al. (2022), as cited in Conradin and Buchli (2004), highlighted that daylighting projects are more feasible in periurban zones due to the availability of land at lower real estate costs. This leveraged the economic advantages for planning and management.

Another significant economic advantage for planning and management can be achieved when projects utilize pre-owned land or initiate projects in public lands. For instance, Hoobyar (2002) points out that in the rural community stream daylighting project in the USA, the project avoided land purchase costs by using land it already owned. This strategy also eliminated the need to relocate businesses, ensuring easier implementation and cost efficiency.

Alternatively, land-owning strategies can align with broader historical or cultural initiatives. The best example of this is the stream daylighting projects in China. Wantzen et al. (2022) as cited in Ye, (2007); Zhang, (2015) describe the projects in Beijing, where the daylighting project was implemented with archaeological excavations. The Yuhe Canal is an important cultural heritage which is an historical canal of China. This integration minimized additional land acquisition while preserving cultural significance.

3.2.3.4 Environmental Restoration

The ‘’Environmental Restoration‘’ theme identifies the actions of restoring and revitalizing the daylighted area. A review of literature presents that the actions of ‘’Environmental Restoration’’ for stream daylighting project can be categorized

under two sub-themes, namely: (i) Stream Restoration and Modification and (ii) Enhancing Landscape Elements.

3.2.3.4.1 Stream Restoration and Modification

Stream daylighting projects demonstrate diverse approaches to stream restoration and modification, addressing ecological, hydrological, and urban development needs.

Wantzen et al. (2022) reports that in France, the Redon and Sonnette streams, after the project establishment and monitoring programs, improved biodiversity and water quality with restoring longitudinal connectivity enabling the return of migratory species, diversified habitats and flow patterns. It also reduced substrate clogging a phenomenon reduces the permeability and porosity of the riverbed, which can have significant ecological and hydrological consequences.



Figure 3.27 Strawberry Creek with concrete rip-raps

(Source: *The Streams Below Our Streets*. (2017, March 9). WTTW Chicago. https://interactive.wttw.com/urbannature/streams-below-our-streets)

At Strawberry Creek (USA), the project utilized repurposed materials like concrete into functional design elements from previous site uses as creek bed boulders, rip-rap, and steps to the water, creating a functional and cost-effective restoration (Pinkham,2000).

Meanwhile, Tibbetts Brook Restoration (USA) actions highlight the importance of preserving the stream qualities by mimicking nature. Molnar (2022) as cited in DPR (2018) explains the goals of improving water quality by reconstructing wetlands, such as reduction of suspended solids and reducing phosphorus. In addition to that, the daylighted area engineered a pathway mimicking the natural streambeds with pools and riffles but being careful not to narrow the stream flow too much (Molnar,2022). The project introduced native planting and species and removed the invasive species that destroyed the natural wetland. They also placed transitional wetland zones to help restore the natural landscape and the ecosystem health.

In the Jolly Creek (USA) Daylighting project, a new stream channel was created with features such as a curved pond with shallows for aquatic vegetation, deep refuges for fish, and root wads for habitat and flow control. Willow plantings stabilized stream banks, supporting long-term ecological balance (Pinkham,2000).

In Indian Creek (USA), daylighting efforts incorporated a multipurpose culvert redesign serving as a stormwater storage tank while integrating upstream solutions like wetlands, rain gardens, and permeable pavements. Community-based initiatives, such as rainwater harvesting and tree planting, complemented these structural interventions (Buchholz et al., 2016).

These cases illustrate how stream daylighting blends ecological restoration and urban planning to create healthier ecosystems.

3.2.3.4.2 Enhancing Landscape Elements

Stream daylighting projects enhance landscapes, creating environments that support both nature and community engagement.

The Jolly Creek Daylighting project achieved significant environmental success, with progressive revegetation of vegetative succession and maturation. The restored sites now feature a rich ecosystem with a canopy of alder, willow, and maple, alongside a redwood overstory exceeding 40 feet, showcasing the long-term benefits of ecological restoration (Pinkham,2000).



Figure 3.28 The thriving wildlife Cheong Gye Cheon Restoration Project established on the south terrace and the pedestrian bridge on the northern side

(Source: Shin, J.-H., & Lee, I.-K. (2006))

Similarly, the Cheong Gye Cheon Restoration Project balanced ecological preservation with public use by emphasizing natural elements while integrating community preferences. The northern side of the stream was designed as a promenade for citizens, while the southern terrace prioritized ecological integrity, reflecting a blend of environmental and social priorities.(Shin and Lee,2006)

Especially, by prioritizing native and locally appropriate vegetation, the stream daylighting projects create sustainable and resilient landscapes that support biodiversity, reduce maintenance requirements, and integrate seamlessly into their surroundings.

At Strawberry Creek, native trees and groundcover, including willows, cottonwoods, pines, oaks, manzanitas, poppies, and snowberries, were used along the creek and uplands. These species require minimal maintenance and irrigation, promoting long-term ecological stability (Pinkham,2000) . Similarly, at Darbee Brook, the stream banks were planted with native species such as willows, poplars, birches, and ash, enhancing natural adaptability and ecological restoration (Pinkham,2000).

At Blackberry Creek, native dogwood was chosen instead of taller species like willow or cottonwood, reflecting community preferences for shorter vegetation while maintaining ecological benefits (Pinkham,2000).

3.2.3.5 Policies and Legislative Regulations

The theme of "Policies and Legislative Regulations'' outlines the support of legal and governmental support in daylighting and stream restoration projects. It highlights the crucial role of legal and governmental facilitation for successful river restoration.

3.2.3.5.1 Legal and Governmental Support

In Taiwan to support the initiating daylighting projects, the government passed a law declaring construction on covered rivers illegal requiring public meetings to ensure support from the public. In Taiwan stream daylighting cases the local authorities had the main initiative to achieve the projects (Wantzen et al., 2022).

As Wantzen et al. (2022) cited as in Water Resources Bureau of Wuhan (2019) in China, the Wuhan Water Resource Bureau decided to daylight a buried area to curb water pollution and create an ecological corridor within a national call from the Ministry of Housing and Urban-Rural Development.

In the case of San Luis Obispo Creek, San Luis Obispo, California, USA (Hoobyar,2002) the stream was covered and transformed into a parking lot.

Exacerbated by the business merchants were determined to expand the parking and serious flooding events; community-wide debates and citizens's committee formation from all representatives decided to initiate the creek's restoration. Supporting the restoration plans, the city council adopted flood management policy and restoration measures. In the case of Cheong Gye Cheon Restoration Project, the municipality introduced new transportation policy focusing on public transportation to cope with the problems emerging from the reduced lanes of road (Lee,2005) .

Overall, there is a strong connection to assist the legal and governmental support in facilitating stakeholder involvement and enabling successful stream daylighting projects.

3.2.3.6 Most Frequently Observed Actions in Stream Daylighting Projects

The content analysis results demonstrate key insights about the actions and strategies implemented in the stream daylighting projects.

Table 3.7 Most Frequently Observed Actions in Stream Daylighting Projects

MAIN THEME	SUB THEMES	Sub-Theme Percantage
Stakeholder Involvement	Active Engagement of Public	12.90%
	Educating Public about Project	11.40%
	Collaboration of Different Authorities	9.80%
Infrastructure Development	Accessibility and Connectivity Enhancements	9.10%
	Water Management Systems	6.10%
	Recreational and Aesthetic Improvements	5.30%
	Structural and Engineering Works	3.80%
	Safety and Nighttime Appeal	1.50%

Table 3.7 (continued): Most Frequently Observed Actions in Stream Daylighting Projects

Project Planning and Management	Development of Integrated Urban Plans	9.10%
	Establishing Project Monitoring and Assessment	8.30%
	Land Management	3.00%
Environmental Restoration	Stream Restoration and Modification	6.80%
	Enhancing Landscape Elements	6.10%
Policies and Legislative Regulations	Legal and Governmental Support	6.80%

Effective '**Stakeholder Involvement'** emerges as the most critical aspect of stream daylighting actions. The sub-themes include:

- Active Engagement of Public (12.9%): Reflecting the importance of involving the public in decision-making processes
- Educating the Public about the Project (11.4%): Public awareness campaigns and educational initiatives are essential for building support
- Collaboration of Different Authorities (9.8%): Coordination among governmental bodies, NGOs, and other authorities is emphasized

Secondly '**Infrastructure Development'** explain improving and developing infrastructure around daylighted streams which is another vital action area. Sub-themes include:

- Water Management Systems (6.1%): Establishing efficient water systems to handle stream flow and prevent flooding is a key action.
- Structural and Engineering Works (3.8%): Technical infrastructure, such as culverts and bridges, is important for project feasibility.

- Accessibility and Connectivity Enhancements (9.1%): Improving access to daylighted streams and ensuring connectivity is highly emphasized.
- Recreational and Aesthetic Improvements (5.3%): Adding features like walkways or parks increases the usability and appeal of daylighted streams.
- Safety and Nighttime Appeal (1.5%): Safety enhancements and ensuring nighttime usability are mentioned but have the least frequency of focus.

Thirdly, '**Project Planning and Management' explains** the comprehensive planning and efficient management . Actions under this theme include:

- Development of Integrated Urban Plans (9.1%): This highlights the need for cohesive urban planning that aligns daylighting projects with broader city development goals.
- Establishing Project Monitoring and Assessment (8.3%): Regular monitoring and evaluation mechanisms ensure that projects meet their objectives.
- Land Management (3.0%): Managing land use effectively to accommodate daylighting projects is recognized as a lesser, but still relevant, action.

Fourthly, '**Environmental Restoration**' focuses on actions that enhance the ecological and visual quality of the stream and surrounding areas. The sub-themes include:

- Stream Restoration and Modification (6.8%): Efforts to restore natural water flow to meet ecological and aesthetic standards are significant.
- Enhancing Landscape Elements (6.1%): Landscaping actions, such as adding greenery or improving streamside aesthetics, play a supportive role in the restoration process.

Lastly **'Policies and Legislative Regulations'** includes supportive policy frameworks and legal regulations underpin successful stream daylighting actions. Under this theme 'Legal and Governmental Support (6.8%)' action underscores the need for legislation and governmental backing to overcome regulatory and bureaucratic hurdles.

CHAPTER 4

RESEARCH FINDINGS

This chapter presents the findings related to two sub research questions: Sub RQ2, which explores ***how do the representatives of local authorities, NGOs, and academia perceive the challenges associated with stream daylighting****?,* and sub RQ3, which examines the ***strategies that experts and relevant stakeholders can adapt to address these identified challenges***.

The interview questions are designed to provide insight into the barriers the stream daylighting in the case of Ankara. For this study, the questions were designed to observe and understand how the current perspective for stream daylighting in practice. The questions focused on several issues regarding the barriers to stream daylighting in the case of Ankara;

a) identifying the **specific challenges of working in a city center or a high-density area**

b) the problems that might arise in terms of **urban infrastructure** during the implementation of daylighting actions

c) the concerns that could emerge regarding **the feasibility and applicability** of such a project

d) the types of issues that could occur in the context of **formal regulations**

e) the difficulties related to **the maintenance and sustainability of the project area** after the project is implemented

f) the **social issues** that might arise

g) The potential challenges in **securing financial resources** for the project

The questions aimed for eliciting the perspectives and assessments of different stakeholder groups on how the current stream burial and stream improvements operate in practice and what are the constraints to stream daylighting. The answers the participants provided added to a nuanced understanding of the perspectives of experts representing diverse opinions regarding the possible process of daylighting, perceptions of barriers, and strategies and thoughts that can be employed to overcome the barriers.

Considering the participants may not know the stream daylighting as there is no example in the Türkiye context, before the interview, I did a presentation on the current problems and risks in Ankara and explained the stream daylighting with the world's most known example Cheonggyecheon River Restoration project (Khirfan et al.,2020d) in detail. This is not only one of the most well-known examples of stream daylighting globally, but Ankara and Seoul are also twin cities that aim to enhance relations between the Republic of Türkiye and the Republic of Korea in political, economic, and cultural fields. They are already engaged in an exchange of information and interaction, particularly concerning urban planning (Özdemir, n.d.).

Even though the primary focus of this study was to explore challenges associated with stream daylighting, participants frequently shared strategies to overcome these constraints. This reflects the inherently interconnected nature of problem identification and problem-solving in practical contexts. Therefore, I employed a more comprehensive analysis by analyzing both the challenges and the actions within the interview results.

In the subsequent chapter, the content analysis from the interview and the case studies will be synthesized to predict the challenges and identify the lacking actions and strategies. This will help uncover the gaps and establish priorities for stakeholders to address effectively.

4.1 Perceptions of Challenges to Stream Daylighting in the Case of Ankara

The in-depth interview results provides insights into ***how stakeholders perceive the challenges to stream daylighting***. Themes with higher frequencies indicates the areas stakeholders identify as critical barriers. Table 4.1 presents the results of the content analysis, highlighting the frequency of mention for each challenge group. The following sub-sections explains each theme in detail, offering perspectives from the participants. Each theme includes counter-arguments and explanations that shed light on the underlying issues contributing to the determined challenges.

Table 4.1 Frequency Analysis of Challenge Themes in Stakeholder Perceptions of Stream Daylighting

THEME	SUB-THEMES	Percentage of Sub-Themes Mentions (%)	Percentage of Total Mentions (%)
Project Management and Implementation Issues	Risks of Social Management of the Project	10.00%	27.20%
	Planning and Programming	6.80%	
	Risks Related to the Physical Design of the Project	6.50%	
	Post-Project Monitoring	3.90%	
Financial Problems	Limited Financial Resources	12.50%	19.70%
	Decision-Makers' Investment Approach and Persuasion Processes	5.70%	
	Project Costs and Unpredictability	1.40%	
Feasibility and Implementation Risks	Construction Phase Issues	5.40%	16.10%
	Technical and Infrastructure Problems and Risks	5.00%	
	The Risk Inadequate Feasibility Analyses	3.20%	
	The Risk of Public Health Issues	2.50%	
Institutional Capacity and Coordination	Lack of Scientific, Technical, and Project Management Capacity in Institutions	7.20%	13.60%

Table 4.1 (continued) Frequency Analysis of Challenge Themes in Stakeholder Perceptions of Stream Daylighting

	Problems in Governance and Decision-Making Processes of Institutions	6.50%	
Social Political Concerns	Social Resistance and Concept of Ownership	6.80%	10.40%
	Political Instability	3.60%	
Problems Related to Participation Processes	Stakeholder Engagement and Communication	5.00%	6.80%
	Social Participation and Awareness	1.80%	
Legal Problems	Implementation of Regulations	3.60%	6.10%
	Gaps in Legal Regulations	2.50%	

The following naming of the organizations demonstrate their group specific codes disclosing participants affiliation. The generic codes are:

- State Authority (LA)
- Local Authority (LA)
- Non-Governmental Organization (NGO)
- Academic Institution (A)

4.1.1 Project Management and Implementation

Analysis results show that the main barrier to establishing stream daylighting in Ankara is the process of project management and implementation categorized into four key themes: (i) Risks of Lack of Social Management of the Project, (ii) Risks Related to the Physical Design of the Project, (iii) Post Project Monitoring.

4.1.1.1 Risks of Lack of Social Management of the Project

The data analysis reveals that the most frequently mentioned challenge related to project management and implementation is the ‘’Risks of Lack of Social Management of the Project’’. Social management is the most significant aspect of project management, as it encompasses many responsibilities such as disseminating information about the project, minimizing interruption to citizens’ daily life and gaining public support.

The interview respondents emphasized the cruciality of the effective management of emotional reactions from institutions and the public for the social management of projects. Academic representatives and public authority participants particularly highlighted the importance of persuasion of the citizens especially the local residents within the project area. On the other hand, representatives from public authorities emphasized the need for a process of public persuasion, the fact that people in society can put individual interests first, and therefore the difficulties of managing crises that may arise. Stream daylighting is an ambitious and costly project which needs fostering excitement and gaining the support of both citizens and public institutions. Otherwise, a **top-down adopted project** has the fate to be doomed which is a specific challenge. Without the persuasion of the citizens, in each progress of the project, there is a risk of societal problems arising.

Especially for the realization of stream daylighting projects, participants from both academics and public institutions highlighted **the importance of the power of the media** and how it can be a tool or a trigger for the project's success. **The lack of project communication and dissemination** can cause difficulty in managing social reactions to such projects. The participants pointed out the social reactions that may grow from ‘’daily social media or in entertainment news (e.g. twitter)’’ which is critically important to manage.

Participants attribute this issue to the risk of urban life disruption caused by the implementation of the stream daylighting project. Various urban life disruptions

affect the project area such as the traffic roads changing and increasing traffic, the construction and demolition process, the process of moving residents or power cuts due to infrastructure changes. It was stated that such projects are especially challenging due to the long construction process. This was explained with a tone of distress by an urban planner, who noted in the following interview excerpt:

> *''The infrastructure, especially in the city centers, is very dense. Therefore, the project may be disrupted and this may take years. This period can be very long. If the construction process takes too long, it can become something very paralyzing for urban life. This is a city where there has been a pothole in Güvenpark for many years. The subway is being dug up and cannot be built for a long time'' (urban planner, NGO)*

The excerpt above highlights the possibility of **reactions that may arise from an improperly planned project**. It is important to explain the long-term benefits of the project correctly, otherwise the public will lose motivation in the process.

A participant from a local authority, also a specialist in strategic planning and international relations, explained how citizens often lack awareness or understanding of the long-term efforts involved in major infrastructure projects, especially in metropolitan areas. Emphasizing that while such projects require years of work, people only notice the final result. Until completion, there is often a **sense of futility or disbelief expressed by the public**. Without people getting informed and potential benefits they would not be able to visualize nor grasp the impact of the project.

Another key challenge in the social management of the project involves community engagement concerns. It was mentioned that one of the biggest responses that needs to be managed in this part is **persuading citizens to accept expropriation**. The expropriation process involves acquiring private property mounting social resistance. Expropriation projects are being carried out in Türkiye and Ankara in conjunction with urban transformation projects, namely ‘’Kentsel Dönüşüm’’, for various objectives such as land clearance, revitalization, conservation, or infill development. The state and local authority participants highlighted that urban

regeneration areas are potential zones for opening areas for stream daylighting. However, there's usually a difficulty in managing both public persuasions for expropriation of private properties and relocating the locals.

On the other hand, the social dimension mentioned by the participant of **the complexity of effectively involving the stakeholders** who will be directly affected by the project (such as individuals, businesses, and NGOs) and managing their needs, considering the process of the project's technical and physical requirements.

Lastly, the results of demonstrates an effective project management and implementation require careful consideration of social risks, particularly in terms of public communication. Maintaining public motivation and awareness of the project's transformative benefits is crucial, as these long-term initiatives can span 4-5 years on average. Clear and informative communication helps the public envision and appreciate the project's outcomes, such as new recreational spaces, which may not be immediately apparent from the technical work alone.

4.1.1.2 Planning and Programing

Content analysis results display that there is a tendency towards acting without planning and programming, which could risk the success of the potential daylighting projects. Participants noted that inadequate planning and programming in projects various problems can result in serious problems. One of the problems is the significant risk of inefficient results of the project and the costly service provision.

One key finding in the context of planning and programing emphasized the importance of prioritizing critical issues to avoid waste of resources. Participants underlined that addressing the most pressing problems in a structured and sequential manner is essential for effective resource utilization. Proper planning and coordination are therefore, crucial to avoid wasting public resources and ensure the effective implementation of projects.

Additionally, the analysis notes the lack of environmental planning in cities contributes to a growing public demand for ecological spaces. This demand, if unmet, creates a vicious cycle for planning and management, further complicating the effective execution of daylighting projects. For example, the interviews revealed additional risks, such as connectivity issues that may arise following the implementation of a stream daylighting project, potentially causing traffic disruptions. To address these challenges, it is essential to plan new connection projects, such as bridges and viaducts, as part of the overall project strategy.

Lastly, results also show that there is a **tendency towards corruption** in such type of projects. To avoid potential challenges such as infrastructure conflicts, and displacement of vulnerable populations, there has to be a caution against the negative impacts of corruption and mismanagement in infrastructural projects. In particular, the participants warned that after finishing the daylighting project, there is a risk of becoming tools for rent-seeking and **gentrification** rather than serving the broader public good.

4.1.1.3 Risks Related to the Physical Design of the Project

Participants highlighted various risks concerning project management related to the physical design of the project area. In the interviews different concerns were discussed critically, including the limited space available for the project area, the risks of not using local species, the failure to restore the ecology, constraints in dense urban areas, and the poor design of project implementation.

One issue specifically pertains to the **landscaping practices and design** within the project area. The projects often **incorporate imported species** instead of utilizing plants suited to the local climate. By introducing new species these practices alter irrigation and maintenance requirements, disrupting the ecological balance in the area. The experts on the matter also added that Ankara’s climate and environment is a unique steppe ecosystem. To do forestation, the plant that can grow should be

expected to be resistant to drought. For that special and separate feasibility studies need to be carried out regarding the impact on the ecology of the area.

Not only choosing the local plants but also, the interaction of the species from ground cover, shrubs, bushes to trees together should not be ignored. It was emphasized that, just choosing the local plants is not enough to provide a convenient ecosystem but the combinations determine the sustainability of the area. On the contrast, a participant who is also an environmental engineer, expressed **concerns about the excessive greening** of the area as follows:

> *"The greening around the stream should not be too intense, this can create two problems. When we plant along the stream, we narrow the cross-section, which can hinder the speed of the flow of the stream and reduce the water flow capacity."*

The necessity of this discourse was also supported public authorities, who frequently remove non-native plants in their practices for this reason.

A concern frequently raised by academia and civil society participants is that the project designs are based on **a rigid design structure**, used for every project and usually adapted and copied projects from abroad. This ultimately disregards the needs of the public and participative planning. Municipalities are criticized for relying on **"copy-and-paste" methods**, both in project documentation and design, with an emphasize that these projects are often superficial and poorly transferred from foreign contexts.

One of the site design concerns was that the study area for **the urban zone was too restrictive**. The reasons for this were that the underlying structures were too dense, and the design would leave a very limited area for the new water ecosystem to be established.

Lastly, **weak and poorly contextualized designs** also lead to higher economic costs, as they often involve technologies and materials that are inappropriate for the project area. For example, the use of non-durable, non-sustainable urban furniture was

mentioned as a factor that would disrupt both aesthetic appearance and function of the space. However, it was mentioned as a risk that such practices are not always due to public institutions' ignorance but are sometimes in line with the demands of citizens.

4.1.1.4 Post Project Monitoring

For the sustainability of the project area, participants warned of the risks of the lack of maintenance, supervision, and operation of the project area. (See also the theme of the "distribution of authority of the institutions")

From the perspective of **technical supervision**, the **pollution of streams** was mentioned as a significant risk, particularly thinking of this system as a part of a rainwater harvesting system. One key concern is the lack of regular cleaning and maintenance of storm drains. After the streams are de-culverted, the rain overflows from the roofs, and apartment buildings, and the pollution of the asphalt can come to the streams again. The maintenance and cleaning of the storm drains are important.

There is also the risk of citizens connecting their sewage to the stormwater channel due to the lack of awareness. The water might be contaminated with the pathogenic substances in the water you collect and transfer from the rainwater channel.

Another post monitoring challenge of the project is the risk of **a lack of community ownership over the area following project completion** highlighting the lack of monitoring of the project area and the public communication. A participant from the local authority explains this situation providing an illustrative example:

> *''In Sancaktepe of İstanbul there was a stream with recreational area here that we opened before the elections. There were even concerts, and many events held there. The area is surrounded by a neighborhood, yet the local community didn't emotionally claim the streamside as their own. Why not? It's likely due to psychological factors—if we had communicated beforehand and created a vision for them, they might have embraced it once it was*

completed. Maybe the whole project's results would have been so different. But we just simply spent the money on just constructing the project and opened it with concerts before the election. The site was stunning; even various events were hosted. However, we have to dismantle everything now. Because the locals did not envision or own the park, and we cannot sustain the area—it's been only four months.''

This example describes how **unwanted public places** are becoming **vulnerable to misuse or vandalism**. A participant from the municipal planning authority, specializing in urban transformation, highlighted the risks associated with inadequate safety measures during the transformation and construction processes. The participant noted that such shortcomings could lead **to areas becoming prone to isolated, unsafe, and unsecure place**, exacerbating the challenges of urban renewal.

Another risk of lack of supervision that may lead to **the pollution of streams** is that citizens may use the open area as a waste area. An NGO participant, environmental engineer, explains this situation:

''For example, go to see the Ankara Stream in Akköprü, look, in the past, there was a sofa set in the stream, there was a car tire, a car radiator, a car door, an accumulator, I have photos of all of them. People throw their belongings into the streambed like trash. Pillows, quilts, what else? They can throw them into these streams too. Therefore, this must be prevented.''

An important issue related to maintenance and monitoring is the lack of responsibility of the investor organizations (e.g. State Hydraulic Works) to ensure operation, maintenance, and sustainability after the completion of the project. Some participants argue that the central administration is incapable of assuming long-term responsibilities such as maintenance, repair, and management of projects as they lack practical experience. They defended the need for a local or different institutional structure that is more experienced in that area to sustain the recreational area. In this way, investment expenditure will not be wasted.

Lastly, **failure to sustain maintenance and repair after investment** is seen as a significant project management risk.

4.1.2 Financial Problems

As shown in Table 4.1, the second most important challenge identified from the analysis results is financial problems. Interviews on this topic suggest that the challenges to implement stream daylighting in the case of Ankara fall into three categories: (i) Limited Financial Resources, (ii) Decision-Makers' Investment Approach and Persuasion Processes and (iii) Project Costs and Unpredictability.

4.1.2.1 Limited Financial Resources

This sub-theme explains the financial constraints due to high investment requirements and land acquisition costs. Insufficient municipal budgets, the lack of access to international funds, and national budget constraints hinder adequate investment in such initiatives. Participants mostly emphasized that this project will be a challenge due to its **high economic cost**.

There are several contexts for limited financial resources, interpreted differently by various stakeholders. The academic and non-governmental organization participants mainly interpreted that due to the size of the project, the size of the budget is a big obstacle economically.

Discussing high economic cost, the **risks of economic crisis** and how it could affect the investment, planning, and implementation of this project creates an important concern. One of the participants illustrates this situation as follows:

> *''The costs of the project may exceed the initial expectations. The country frequently experiences economic crises, the dollar can fluctuate dramatically overnight. For example, let's say, the local authorities decided to undertake such a stream rehabilitation project, or a rainwater harvesting project. They*

decided to go out to tender a year ago, they would set the prices based on the time frame and determine a range. However, no bidders are willing to participate as they can't complete with the cheaper costs, the previously determined costs now. That temporality and economic volatility hampers such long-term projects. And these types of infrastructure projects are always long-term and big-budget projects. So even a rise in the dollar from 33 liras to 33.5 liras has very dramatic consequences for the project.''

Academic and NGO participants raised concerns about **the high cost of expropriation**, particularly in the metropolis of Ankara, where it involves significant expenses that complicate the process of securing loans or grants. Furthermore, state authorities pointed out that the local authorities' capacity is insufficient to handle such large-scale infrastructural projects. In relation to this concern, state and local authority participants justified these issues by citing three main reasons.

The first one is the **failure to obtain international funds** and the economic burden that it will bring. This sort of daylighting projects calls for international funding, but the public generally does not prefer it because it is repayable and the loans it creates in the long term. The failure to secure international funds for the project are attributed to several factors. One critical issue, as highlighted by an expert in strategic planning and international relations, is **jurisdictional uncertainty**, which discourages international financial institutions from providing support. Additionally, **the lack of comprehensive and accurate reports on the project's environmental and social impacts** presents a significant barrier. These reports are essential for demonstrating the feasibility and sustainability of the project, particularly in detailing how sensitive aspects such as expropriation processes will be managed. Without addressing these challenges, obtaining international financing remains a considerable obstacle.

The second issue is that urban city centers require significant financial resources and advanced planning capacity. Expropriation in city centers is in higher value and

higher demand areas. Demolishing buildings and structures and relocating residents can create a financial burden for project implementation.

The third issue is the lack of adequate funding for such projects as well as ensuring projects are not left incomplete. Infrastructure projects are inherently expensive and time-consuming, making them **vulnerable to delays or abandonment** when resources are insufficient. In addition to that, the local authority mentioned that the national budget is limited means, there is a national current account deficit. Therefore, national financial spending prioritizes basic needs.

4.1.2.2 Decision-Makers' Investment Approach and Persuasion Processes

Another sub-theme of financial problems is the "Decision-Makers' Investment Approach and Persuasion Processes''. Under this theme, participants discussed the risk of the project not being prioritized in the budget planning and the project not being seen as a priority for the collection of equity. This issue seems to be a critical issue defined by the public authority and NGO participants.

The most mentioned problem under this theme is the perception of the lack of budget allocation according to the participants. The local authorities interpreted that **stream daylighting might not be considered a basic and urgent need from the perspective of investors**. Among the reasons for this, the difficulty in securing financing, especially as decision-makers find projects of "this type" to be unorthodox and costly projects.

4.1.2.3 Project Costs Unpredictability

The last sub-theme under the financial problems discussed is project cost unpredictability. The risk of unpredictable costs arising during the construction process remains as a concern. According to the study findings, infrastructure project

costs can be difficult to predict accurately, as unexpected infrastructure issues or other factors may arise during the project process. This can lead to higher expenses than anticipated. Budgets may need to be adjusted as the project progresses due to these unforeseen cost increases. A participant put it as:

> *''You may not be able to foresee the cost, costs may increase in some areas after you get involved. For example, you may think this is only a rehabilitation of a stream bed, but you may need to spend much more money during the construction process. Which is usually the case anyway, unpredictable costs arise.''*

Another concern is the risk of wasted economic resources in the case of faulty planning such as insufficient feasibility analysis. Additionally, the uncertainty of sponsorship and support mechanisms causes cost unpredictability.

4.1.3 Feasibility and Implementation Risks

The third most mentioned main challenge, accounting 16% of responses, is ''Feasibility and Implementation Risks''. According to the interviews, the key challenges and risks in the feasibility and implementation of projects to uncover and restore streams are categorized into four main groups, listed in order of frequency: (i) Construction Phase Issues, (ii) Technical and Infrastructural Problems, (iii) The Risk of Inadequate Analysis and (iv) The Risk of Public Health Issues.

4.1.3.1 Construction Phase Issues

A notable trend in the data was the consistent reference to ''Constructions Phase Problems'', which were mostly concerned and mentioned by the public authorities. One major challenge is the difficulty in **relocating or rerouting existing underground infrastructure**, such as power lines, gas lines, water lines or sewage systems. Managing these system during excavation is technically complex and can lead to significant disrupt in daily life, including traffic congestion or power outage

in the surrounding neighborhoods. Additionally, rerouting major arterial infrastructure that affects multiple neighborhoods which are consistent in Ankara can complicate and prolong the planned construction process.

Moreover, **unrecorded or unforeseen infrastructure poses** major risks of unexpected encounters. One of them is the climate change impacts that may lead to underestimating flood discharge, requiring larger infrastructure as a construction. It was also stated that archaeological discoveries could disrupt the entire construction process predicting such risks is difficult, especially in urban areas which are also hard to execute projects to analyze in Ankara. Archaeological remains can potentially hinder the process, just as excavations can also cause damage to archaeological remains.

Furthermore, unforeseen infrastructure risks can occur due to some geological factors. A participant illustrated these risks with the following excerpt, referencing the construction process of the Kızılay Metro Project:

> *"During the process of the excavation and building walls around the subway line; it was realized that some buildings in the city center, Kızılay, started to lean towards each other. After the investigation, it was realized that it was due to ''Ankara Clay'', a material that swells as it absorbs water, which is unique to the city's geological formation. The reason for buildings starting to lean towards each other was that the walls built around the subway line were blocking underground streams, acting like a dam, and causing water to accumulate. Therefore, Ankara clay swells with the water accumulation, causing buildings to start leaning toward each other."*

Another challenge in construction processes is that the **denser infrastructure in urban centers complicates processes**. As urban centers include a higher density of underground infrastructure, such as metro lines, gas pipelines, water and sewage systems, and telecommunication cables, the construction processes require specialized engineering expertise, particularly for water-related work. In terms of project scale, the participant from the local authority, which is an expert in civil

engineering, reported that the scale and complexity of urban infrastructure, such as large-diameter sewage pipes, pose significant challenges compared to less densely populated areas. These factors increase the difficulty and risks associated with construction projects in city centers.

Lastly, the analysis shows that there is **difficulty in demolishing structures** to achieve stream daylighting. There are risks posed to the surrounding structures and for people, requiring detailed technical, careful, and safety prioritizing planning.

4.1.3.2 Technical and Infrastructural Problems

The most frequently mentioned issue in terms of technical and infrastructural problems is the **absence of a separate system for wastewater and rainwater**. The practice of covering over and burying natural waterways fails to address the underlying problems and can create new challenges. Pollution and contamination of urban waterways due to untreated wastewater discharge, lead to severe environmental degradation and health hazards. This is specifically critical as the potential daylighting project can be affected by the contamination of sewer water. The participants warned that the high possibility of the most **buried streams in Ankara is contaminated by the sewages**.

The participants indicated that if the streams are already utilized as a component of the sewage system, then it will be necessary to redirect that sewage alternative locations to eliminate the role these streams currently play in the system. It was also noted that a rainwater drainage system is required alongside the stream daylighting project. As it is currently lacking in heavily urbanized Ankara, it is necessary to ensure the integration of the feedback system through the rainwater drainage system together with a stream daylighting project.

The problem of **incomplete or inaccurate mapping of underground infrastructure** in city databases creates unforeseen obstacles for the infrastructural

project execution. A participant from academia, who is also an expert in water and waste management, explained the lack of infrastructural data as follows:

> *"I'm familiar with the drinking water sector. When I visit certain areas, the location of some pipes passing through certain streets is known only by the repair technician who responds to service calls in that area. Other than that, no one knows, and it hasn't been mapped. This is true for certain areas in Ankara as well, though not everywhere. What does this mean? First and foremost, there is a lack of data.".*

The participant also highlighted **the privatization of urban infrastructure systems** leading to a fragmented management landscape, where responsibilities are divided among various entities with differing priorities (see ''Legal Problems''). Essentially it is causing **the lack of comprehensive mapping and data availability** for the existing infrastructure.

This data deficiency interferes with effective planning and coordination between different infrastructure systems. The participants also reminded in this context that only water supply and wastewater management remain under public ownership, while other utilities, such as natural gas and electricity, have been privatized. This creates challenges in integrated infrastructural planning when addressing overlapping systems such as wastewater, rainwater drainage, and utility networks.

4.1.3.3 The Risk of Inadequate Feasibility Analyses

The next subject frequently mentioned is the '' The Risk Inadequate Feasibility Analyses '' mainly concerned by the NGO's and academic participants. In the case of **conducting inadequate feasibility analyses**, there are risks of opening dried streams or having insufficient water flow in a stream daylighting project in the context of Ankara**.** This can be especially hindered by periods of drought accompanied with reduced groundwater recharge and the diversion of water for other

uses. Therefore, the potential for restored streams can become stagnant and malodorous if proper water flow and ecological restoration are not achieved.

There is also a risk of carrying out the project while **disregarding climate change projections and associated risks**. A participant, specialized in projects for soil and water resources preservation, expressed this concern over:

> *"Climate change is a very important factor in this feasibility study. If we open a typical stream in Türkiye, today, we will see, there's just a small amount of water left in it. This is likely due to the water being used or retained from its source through dams, hydroelectric plants, or other means. But ultimately, most of Türkiye's rivers, in 10, 20, or 30 years, may experience significantly reduced flow rates. So, we spent so much effort, invested millions or billions of dollars, and worked for years to open these streams. Why did we open them?"*

This emphasizes the broader concern that significant investments in stream restoration projects may be wasted if fundamental hydrological conditions and long-term climate projections are not adequately addressed in the planning process.

4.1.3.4 The Risk of Public Health Issues

The last sub-theme of the "Feasibility and Implementation Risks'' is the '' The Risk of Public Health Issues ''. Some potential public health issues could arise from the daylighting project. Specifically, there are concerns about **the risk of disease outbreaks**, due to the mixing of wastewater and surface water in open drainage systems. Not only disease outbreaks but also uncovering streams polluted by untreated sewage poses **mosquito breeding in stagnant waters** is another concern. Careful planning is needed to mitigate these environmental and health risks. As explained by a participant, highlighting the historical causes of covering streams:

"The covering and rehabilitation of streams originally emerged a reason—it wasn't done arbitrarily but based on public health concerns. There are many swamps, and they cannot control public health with this much water within the city. If we reopen these streams now without proper planning, we may once again face the same public health issues."

4.1.4 Institutional Capacity and Coordination

The theme of ''Institutional Capacity and Coordination'' appeared in 13.6.% of the frequency analysis. The key challenges identified in this category can be explained under two sub-categories: (i) Lack of Scientific, Technical, and Project Management Capacity in Institutions and (ii) Problems in Governance and Decision-Making Processes of Institutions. The themes mainly explain that there is a lack of expertise, technical know-how, and insufficient established processes for conducting feasibility studies.

4.1.4.1 Lack of Scientific, Technical, and Project Management Capacity in Institutions

''Lack of Scientific, Technical, and Project Management Capacity in Institutions'' represents the challenges faced by institutions, particularly in their technical, administrative, and financial management capabilities.

According to the participants, achieving stream daylighting is hindered by the lack of technical and project management capacity within public institutions. These deficiencies manifest across in multiple ways. Participants noted **recurring errors in interventions made to stream beds**, emphasizing the lack of technical expertise and proper planning. Inappropriate actions exacerbate existing issues rather than

resolving them, illustrating **institutional shortcomings in both understanding and addressing hydrological systems**.

There is an absence of established practices for stream daylighting in addition to the ecological restoration in Türkiye. This issue demonstrates that **a lack of structured applications or standardized practices**. This gap hinders the ability to replicate successful projects or learn from existing models.

Another challenge is that economic perspective in decision-making. Public personnel reportedly approach stream daylighting projects predominantly from an economic viewpoint, overlooking environmental, social and alternative technical considerations. This limited perspective restricts the scope and effectiveness of such projects. As one participant put it:

> *"Unfortunately, in our master plans, we used to conduct feasibility studies solely based on economic criteria. For the first time, while working in the planning department at my workplace, I attempted to assign monetary values to social benefits as well. Because of social benefits, those "invisible benefits" like the environment were not even on the agenda back then. I tried to bring these up as a component of planning, but I was not successful because I didn't have any foundation to support it."*

> *"There's no standard for measuring these things. One is twenty liras, the other is ten liras. Do you understand what I mean? The feasibility of your project comes into question here. All public institutions will interpret feasibility this way: What is the cost of this? This is the solution. How much does this solution cost? The result is that they provide the same function, but we will choose the cheapest one.''*

This highlights that the preparation phase of stream daylighting projects carries the risk of the **selection of the cheapest option**, without considering the broader benefits of the sub optimal.

The following concern was that the institutions continue to **rely on older technologies and methodologies**, which fail to address current project demands. Especially, climate change impacts further complicate technical design to meet the requirement of the flood management strategies.

It was also mentioned that central administration lacks adequate oversight and monitoring of projects, as they are not equipped to handle the ongoing maintenance and operations required for such "living organisms" like parks and recreation areas. Investor organizations that typically manage construction projects are not suitable for ensuring the long-term sustainability of these types of projects. (This is also co-related with the “Conflicts Over Jurisdictions”)

In addition, institutions **lack the qualified human resources and expertise** to properly assess the technical feasibility of the stream daylighting projects, especially requiring complex, multidisciplinary initiatives beyond traditional engineering or construction. As a result, institutions are unable to prepare the necessary technical guidelines and specifications for stream daylighting initiatives, as well as effective landscape design and implementation.

Institutions were also reported to struggle in **establishing effective financial partnerships** at both national and international levels. Specifically, there is a lack of knowledge and expertise in accessing and managing international and domestic funding sources, developing project proposals, and effectively utilizing and reporting on funding. This gap explained as;

> *“In the process of securing financial resources, it is especially important to get to know international actors, to select the most appropriate ones, to transfer their projects to them, and understanding how do they use this whole transfer process after they receive the money? After they receive this fund from the World Bank, how do they use it, communicate this and so on. Either the receiving institutions need to be open for this or they will use an intermediary organization, that capacity is more. Overcoming these challenges is important.’’*

While financial difficulties were acknowledged, participants also emphasized that the core issue stems from a lack of expertise in financial and project management rather than a mere shortage of resources. This lack of proficiency hampers the efficient allocation and utilization of available funds.

4.1.4.2 Problems in Governance and Decision-Making Processes of Institutions

The second sub-challenge of ‘’Institutional Capacity and Coordination’’ is the ‘Governance and Decision-Making Processes of Institutions’.

The problems with clearly defined roles, responsibilities, and authority limits between institutions lead to overlapping jurisdictions, lack of flexibility, and potential conflicts. The repeated mention of **conflicts over jurisdictions** and **unclear authority boundaries** by central and local authorities indicates a shared concern among the group regarding its impact on institutions. For example, flood management responsibilities in Türkiye are shared between the State Hydraulic Works (DSİ) and municipalities, leading to jurisdictional conflicts. While the State Authority (DSİ) and municipalities both have legal obligations, municipalities lack special expropriation authority, which creates significant delays in implementing flood management projects specifically important to uncover streams too. In addition to that, while the central authorities have the full power for the construction over the disaster zones such as demolishing, evacuating, rebuilding; the municipalities have to undergo a lengthy legal process to complete expropriation. This causes delays in the installation of the project, both the municipalities and the residents had to wait for the legal proceedings to be concluded.

There can also be conflict over jurisdiction between metropolitan and district municipalities. There is a need to assign responsibility to a single entity to ensure accountability. A participant pointed out the "two-headedness" in investment responsibilities. The duality in investment and operational responsibilities creates inefficiencies in managing water infrastructure. The infrastructure projects often

overlap with other domains, adding to the complexity of governance and responsibilities.

Another critical issue is that some of the participants mentioned that their institutions cannot be responsible for a stream daylighting project, avoiding responsibility and lacking any initiative. This may indicate **a lack of collaboration between the institutions or complex bureaucratic processes**. A participant from the public authority clearly stated that their department was not responsible for the matter and redirected it to other relevant entities while reflecting skepticism about the feasibility of restoration efforts. Another public authority discussed that their organization performs its duties "and even beyond," where municipal capacities are insufficient. Implying that this much reliance creates an **imbalance in institutional capacity to provide comprehensive flood management**.

The results also shows that **convincing high-level decision-makers** to support and approve projects like stream daylighting is particularly challenging. Decision-makers often hesitate to provide funding from their limited financial resources and this type of project may seem secondary compared to the fundamental needs. Gaining their support requires establishing a dialogue and demonstrating the value of the project, which can be difficult given the lack of precedents in Türkiye. Additionally, they criticized that such long-term beneficial projects, like daylighting rivers, the future of it is uncertain from the perspective of the public; making it hard to **secure funding and public support**, as they are often seen as secondary priorities compared to more appealing mega-projects.

Participants criticized that proposals presented to decision-makers are often met with verbal approval, like "we will do it" or expressions of open support but rarely translate into concrete actions. There is a failure among decision-makers to take timely action and **effectively utilize available opportunitie**s. The tendency to deflect or sideline critical proposals undermines trust in project processes and restricts progress. According to participants, such inaction, especially in high-

priority projects, leads to lost opportunities, reflecting decision-makers' reluctance or inability to act.

4.1.5 Socio-Political Concerns

''Socio-political Concerns'' in stream daylighting are divided into two categories by order of frequency: (i) Social Resistance and Concept of Ownership, and (ii) Political Instability.

4.1.5.1 Social Resistance and Concept of Ownership

The analysis of the interviews demonstrates that relocating residents can be challenging, as people are deeply attached to their homes and properties. Convincing the public is difficult, as many have a **strong sense of private property ownership**. Convincing them to move is stated as a complex social and financial challenge. A public authority highlights this as follows:

> *"Even a 1-meter strip of land near streambeds is claimed as personal property by the public, making expropriation very difficult. Streambeds and their surroundings are extremely valuable."*

Not only expropriation challenge but also there is a challenge due to the understanding of the ownership according to the participants. A public authority described property ownership as a deeply rooted national and cultural issue. According to the participant, the concern with obtaining and securing deeds is instilled in people from a young age, influencing their behavior even during childhood. For example, the neighborhood children while playing may argue over a spot, saying ''Is the deed for this place yours?'' (*Tapusu senin mi?)* to the other. This mindset of how the concept of property ownership becomes ingrained early in life underscores the complexity of resolving property-related issues in projects intended for public benefit. Therefore, overcoming these societal barriers and gaining public

acceptance can be very challenging to persuade residents about the expropriation and relocating.

Resistance to innovation also remains as a significant challenge for the implementation of stream daylighting in Ankara. Society is accustomed to traditional solutions and is often reluctant to embrace new approaches, even when they may be more effective or environmentally friendly. One academic participant explained this issue as:

> *"Uncovering the stream above the asphalt is a solution to correcting a previous mistake. But here, the idea of something new—the fear of innovation—is something that everyone is wary of, not just public employees but also the citizens."*

This resistance stems from a deep-rooted attachment to familiar practices and a fear of the unknown. This is also attached to the lack of public awareness. According to the interview results, understanding awareness gaps through the public is crucial for effectively tackling societal problems. The participants defined this gap for various reasons. One of them is the public failure to recognize the flood prevention methods or the public's unawareness of the technical aspects and the importance of preserving natural drainage systems. Another gap is the lack of understanding of infrastructure development projects and the public may lose their motivation or temper as they cannot understand the overall process. There is a **lack of environmental awareness between the citizens,** reports the participants explaining that there is a lack of demand in the natural green areas. Also they noted that, some people in society may find natural areas dirty and unnecessary in the city, preferring asphalt cover. Another complaint and risk were that the streams were already used as waste areas, where many people throw their belongings and due to this habit, there is a risk of continuity if the streams are uncovered.

4.1.5.2 Political Instability

Political Instability poses significant challenges for local governments in implementing long-term infrastructure projects according to the perception of the participants from all groups. The most mentioned political instability problem is the period of election cycles (every 5 years) may discourage mayors from undertaking ambitious, multi-year infrastructural initiatives. A participant states the problematic nature of election cycles for such project highlighting the risks of incomplete project:

> *"The fact that local elections are held every five years creates a significant challenge. Projects may be left incomplete, leading to new problems, especially if they fail to align with a comprehensive master plan. An incomplete plan can be just as detrimental as having no plan at all, as the consequences are unpredictable. For such long-term projects, there needs to be a vision that extends beyond the mayor's term in office, along with sufficient authority for mayors to implement them. While such authority technically exists, plans remain in effect due to a lack of enthusiasm for creating new ones—they are often not implemented. For instance, while projects are supposed to be implemented within phasing process, they frequently remain unexecuted. This highlights another potential issue with such projects: the risk of them being left unfinished.''*

In addition, participants emphasized such project can causes the municipality's long-term debt accumulation that they cannot spend on other services and the invisibility of the project from the perception of the citizens.

> *"These projects take too long to complete. A mayor's term in office is at most five years, and if they undertake such a project, they won't be able to finish it within that timeframe or allocate sufficient resources to it. In addition, there's often no visible activity related to such projects that can be directly perceived by the citizens. Rather than that, resources can be diverted to more visible, socially impactful projects above ground. For example, instead of*

addressing this issue, a mayor could use the same resources to provide meals to one million people daily, which would guarantee their re-election. Alternatively, they could serve fewer people—say, one hundred thousand—and use the remaining resources for these underground projects. However, they typically avoid doing so.''

The results show that deep political polarization in society can lead to strong opposition to projects, even if they benefit the broader public. That can cause some people to interpret the project with prejudice trying to undermine the project.

4.1.6 Problems Related to Participation Processes

Problems related to the participation processes are grouped under two sub-themes: (i) stakeholder engagement and communication, (ii) public participation and awareness.

4.1.6.1 Stakeholder Engagement and Communication

One key challenge related to stakeholder participation and communication is the lack of institutional knowledge, experience, and continuous improvement in implementing participatory processes. **Decision-makers and project executors lack knowledge about the importance and methods of participatory processes**. One participant explains this as follow:

"Our biggest problem and perhaps the most significant obstacle in carrying out such projects lies in the entire process—from planning to implementation and finally to the usage phase—where the users of the project will be there, and those people will be affected by it. We don't understand the importance of participatory processes. Moreover, we don't know how to carry out these participatory processes. Whether it's the local government or larger entities like ASKİ, ABB, or even the Ministry of Environment if it's a bigger project,

multiple significant institutions are involved here. The individuals involved—workers, decision-makers, and those who implement these decisions—also lack awareness about participatory processes."

Reflecting this issue, participants also mentioned the **lack of coordination and communication between different institutions** (see also Governance and Decision-Making Processes of Institutions, Institutional Capacity and Coordination). This is often criticized as exemplified in the following extract:

"In a participatory infrastructural project, we noticed that there is a serious problem when one directorate within the same institution does a project that is similar to another project done by a different directorate, and they are unaware of each other's work. This is a very significant difficulty and a concern about the feasibility of implementation. Two directorates, with offices next to each other, and two directors who are not aware of the projects each other are working on, despite their projects overlapping significantly, is a major issue. This reflects how weak the participatory approach is in this country. That's why, I guess, at the very top, the biggest issue is the lack of participation."

This is a significant risk for a stream daylighting project, as tensions and disconnects between local and central government authorities, which can hinder the inclusive participation of all relevant actors in large-scale projects. This is explained by, **the fear of the complexity and chaos associated with participatory processes** and, **perceived risks of adopting innovative solutions** out of familiar ways of working, which leads to a preference for top-down approaches.

In addition, there were concerns in public authority, involving and managing stakeholders who will experience direct impacts from a project implying that there is even a challenge in resolving daily conflicts in the implementation process. The lack of information and awareness of stakeholders, both in the effects of climate change and the potential benefits of uncovering stream, is a significant risk to surpass.

4.1.6.2 Public Participation and Awareness

There are challenges in public participation and awareness in urban development projects. This issue includes **lack of community ownership and investment**, psychological barriers to engagement, and the need for sustained public involvement throughout the design and implementation process.

According to the content analysis results, effective public participation is crucial but can be hindered by low awareness and a tendency to postpone addressing persistent problems like inadequate infrastructure. For example, since flooding and heavy rainfall are not experienced regularly, individuals do not consistently encounter the catastrophic effects of such weather events. This causes the tendency to delay addressing the issue and the urgency to resolve it diminishes over time. Consequently, the lack of urgency may hinder efforts to find long-term solutions.

4.1.7 Legal Problems

The last challenge group coded in this study represents "Legal Problems". Legal problems regarding Ankara's stream daylighting are categorized in two main issues: (i) Implementation of Regulations, (ii) Gaps in Legislation.

4.1.7.1 Problems in the Implementation of Regulations

There are several challenges and risks related to the implementation of regulations. First of all, there are inconsistencies between legislation and practice. Mainly because of the disconnect between policy discussions and actual implementation, with plans often remaining on paper rather than being realized.

The results reveal that current legislation fails to provide actionable guidance, enforceable standards, or solutions in innovative areas such as rainwater and greywater management. Regulations that are too rigid or narrow, fail to account for local context and needs, resulting in unintended consequences during

implementation. Also, there is a lack of a harmonized legal framework to achieve stream daylighting as there can be legislation conflicts between different sectors such as agricultural land, forest land, and water management.

The participants report that the existing **expropriation law (Kamulaştırma Kanunu)** requires a formal and lengthy process. This involves compensation and potential court rulings during the project preparation and implementation. This results in delays because of the legal procedures for acquiring land. Legal and bureaucratic hurdles around land acquisition and expropriation can significantly delay projects.

These bureaucratic hurdles generally cause inefficient legal processes in infrastructural projects. The participants highlighted inefficiency in the legal process such as the limited expropriation authority for specific projects, time-consuming legal processes, and problems of practical implications on project timelines. Creating significant obstacles for stream daylighting and creating frustration and inefficiencies for the public authorities.

4.1.7.2 Gaps in Legislation

There are also challenges and risks related to legal issues and gaps in legislation. One key concern is the lack of coordination and alignment between various sectoral laws and regulations (e.g., forestry, agriculture, urban planning) that impact integrated flood management and river restoration efforts. These require extensive harmonization to ensure smooth implementation.

Participants specifically emphasized the absence of a comprehensive national flood law, with only a draft currently under development. This law is crucial for the successful uncovering of buried streams.

Lastly, the lack of specific legal authority for public authorities to undertake expropriation and redevelopment represents a significant gap in the legislation that need to be addressed.

4.2 Perceptions of Actions to Stream Daylighting in the Case of Ankara

The second part of the analysis presents the results of in-depth interviews results questioning ‘’***What strategies can experts and relevant stakeholders employ to address identified challenges?’’***. Themes with higher frequencies indicate the areas stakeholders identify as the prioritizing strategies and actions for resolving the critical barriers. Table 4.2 presents the results of the content analysis, highlighting the frequency of mention for each action group. In the following sub-sections, each theme is described in detail, offering perspectives from the participants.

Table 4.2 Frequency Analysis of Challenge Themes in Stakeholder Perceptions of Stream Daylighting

THEME	Percentage of Total Mentions (%)	SUB-THEMES	Percentage of Sub-Themes Mentions (%)
Project Management and Planning	38.8%	Cross-Scale Planning and Phasing	19.0%
		Communication and Dissemination	11.6%
		Conducting Feasibility Studies	8.3%
Project Site Selection and Design	15.7%	Sustainable Urban and Landscape Design	10.7%
		Land Acquisition	5.0%
Public Participation and Public Awareness	14.9%	Enabling Public Participation	9.1%
		Raising Public Awareness	5.8%
Technical and Infrastructural Development	8.3%	Rainwater and Sewage Management	6.6%
		Data Collection and Empowerment	1.7%
Financial Management	8.3%	Conducting Cost Benefit Analysis	5.0%
		Securing Diverse Financial Resources	3.3%

Table 4.2 (continued) Frequency Analysis of Challenge Themes in Stakeholder Perceptions of Stream Daylighting

Institutional Capacity and Governance	7.4%	Increasing the Transparency and Accountability of Institutions	2.5%
		Improving the Participatory Processes of Institutions	2.5%
		Strengthening Institutional Capacity	2.5%
Legal Strategies	6.6%	Protecting and Preserving Streams	3.3%
		Strategic Decisions in Planning Processes	3.3%

4.2.1 Project Management and Planning

Analysis results show that the main prioritizing actions to establishing stream daylighting in Ankara is the process of project management and implementation categorized into three key themes: (i) Cross-Scale Planning and Phasing, (ii) Communication and Dissemination, and (iii) Conducting Feasibility Studies.

4.2.1.1 Cross-Scale Planning and Phasing

First, the participants outlined the need for **incremental and comprehensive planning** in establishing a stream daylighting project in Ankara, especially concerning the lack of planning and programming (see Chapter 4.1.1.2, Planning and Programming). This includes **developing a master plan** that aligns upper-scale planning with detailed sub-scale plans, addressing hydraulic models, infrastructure master planning, and effective transitioning phase programs to avoid disruptions.

The participants noted the necessity of **working at regional or watershed scales**, requiring interventions beyond administrative project boundaries and for instance, addressing pollutants from industrial sources or incorporating wastewater treatment systems. Stakeholders suggest starting with the uppermost parts of a watershed to address pollution and separate stormwater from wastewater, moving gradually downstream which will make it easier to find funding for the project too. **Ensuring**

the sustainability of water resources is a critical component of a potential stream daylighting project. The participants outlined that the efforts must include maintaining and enhancing water sources over the long term. Without such initiatives, dry parks with dry streambeds may result in the burying of the streams again. The project must ensure the conducting of long-term studies aimed at increasing water sources.

Secondly, participants from all stakeholder groups suggested that **conducting small-scale pilots** as a preliminary step, particularly in areas with high potential but requiring significant reconstruction is a potential for persuading the public to get accustomed. Pilot projects that are initiated with municipalities can provide opportunities to showcase both economic and aesthetic benefits, fostering public and institutional confidence in the project's viability.

4.2.1.2 Communication and Dissemination

Regarding project management and planning, the second key action suggested by the participants is effective communication and dissemination of the project.

Communicating the project's goals and benefits to the public in an accessible manner throughout the project's lifetime is necessary to maintain public support and address any emerging issues. This ensures the restoration project does not negatively impact the community's health or well-being.

One of the key emphasized actions is involving diverse stakeholders, such as the private sector, NGOs, and interdisciplinary experts, to ensure a comprehensive approach that addresses the economic, ecological, and social impacts of the project. **Adopting a multi-stakeholder and interdisciplinary approach** is essential for projects. It is emphasized that stakeholders should be informed about the project through various methods such as visualization of the project, detailed reports, and participative workshops.

Additionally, persuading the local communities and organizations is essential for project ownership and successful social and economic implementation of the project. One participant illustrated this point by stating:

> *"For example, in the Imrahor Valley, numerous real estate offices have been established, such as those in the Karataş neighborhood, all working to monetize individual plots of land. These stakeholders need to be convinced beforehand that green and blue infrastructure can also be profitable, offering alternative investment opportunities with significantly better economic returns."*

Finally, after the project establishment celebrating the project's completion and jointly promoting its achievements can foster a sense of collective accomplishment and strengthen the project's long-term sustainability.

4.2.1.3 Conducting Feasibility Studies

The participants strongly recommended **presenting sufficient and well-prepared projects** with strong justifications. The groundwork must be thoroughly prepared to the extent that no one can oppose the initiative. According to the participants conducting extensive research from various disciplinary perspectives (ecological, economic, sociological) to understand the nature and characteristics of the project area is necessary. While conducting the feasibility studies, the participants emphasize the need for a **multi-disciplinary approach**, thorough data collection, and analysis.

Feasibility studies are crucial for project management and planning, particularly analyzing the water sources and flow patterns in the streams throughout the year to determine their reliability and potential for deculverting. It is vital to conduct studies to **ensure the presence of a consistent water** supply taking account of the historical context of the streams.

In addition to the comprehensive feasibility studies, the participants from the public authority emphasized the significance of establishing clear guidelines in the **maintenance and monitoring operational procedures**.

4.2.2 Project Site Selection and Design

Under the theme of "Project Site Selection and Design", the interview reveals two primary actions, (i) Sustainable Urban and Landscape Design and (ii) Land Acquisition.

4.2.2.1 Sustainable Urban and Landscape Design

The participants highlighted the importance of incorporating **multifunctional and multi-use spaces** in terms of the project area urban design. The project area should be integrated, thoughtfully designed green spaces that **reconnect people with water**. These spaces should provide functional, aesthetic, and social value, fostering community engagement and improving quality of life. While emphasizing that such spaces should be designed to cater to diverse user needs and support various activities. These include areas for recreational purposes such as small-scale sports, and community gatherings, tailored to the specific characteristics and demands of the urban context. Especially selecting urban features and materials with sustainability in the project area such as for the urban furniture for the long-term success of such initiatives. This approach ensures that the project remains functional and environmentally resilient over time.

In addition to that the participants highlighted the need for sustainable landscape design. A participant pointed out the unique characteristics of the Ankara's natural landscape and climate:

> *"The steppe is a very unique ecosystem. If you are working in a steppe ecosystem, reforestation is not always the right thing to do. Let's say you've*

identified areas for reforestation. Then, which trees will you plant so that they can grow? They are expected to be drought resistant."

Another participant suggested that urban gardens *(bostan)* along the streams can elevate the quality of the ecosystem.

In landscape design, the most important aspect emphasized was the careful selection of plants and area design elements. The necessity of utilizing **local plant species** was particularly highlighted, as they are better adapted to the regional climate and ecological conditions, ensuring sustainability and ecological balance in the project outcomes. In addition, the selection of the plant species should be optimized in order for them to harmonize in a common ecosystem, the overuse of the plants can also harm the ecosystem in the area.

Participants highlighted the importance of reusing **water circularly** within basin systems such as utilizing cistern systems constructed to control flooding. These systems store millions of liters of water beneath urban areas, which can then be discharged and repurposed for agricultural irrigation. Utilizing various methods to cope with flood risks but also integrating water use into a sustainable cycle within the basin, promoting efficient resource management.

4.2.2.2 Land Acquisition

Participants discussed the strategies for land acquisition as it is one of the critical barriers for a potential daylighting project in Ankara. One of the strategies is to avoid working in high-density areas or city centers when planning stream daylighting projects. Instead, the focus should be on locations where water flow can be easily regulated, and existing water resources can be utilized effectively. As a stream restoration project creates a new green corridor, the creation of new corridors in dense urban regions poses significant challenges due to the presence of extensive existing infrastructure. As a result, **less dense peripheral areas** are considered more suitable for such projects.

Additionally, according to the public authorities, integrating into an existing corridor or creating a new corridor designated with urban renewal initiatives can enhance feasibility. Such initiatives should be directed with legal regulations within the upper-scale plans and new legislations.

4.2.3 Public Participation and Public Awareness

The third most mentioned main actions stakeholders addressed, accounting %14.9 of responses, is "Public Participation and Public Awareness''. The interviews analysis shows that the key social interventions in uncovering and restore streams are categorized into two main groups, listed in order of frequency: (i) Enabling Public Participation and (ii) Raising Public Awareness.

4.2.3.1 Enabling Public Participation

Several participants pointed to "Enabling Public Participation" as an effective solution, for the barriers of the stream daylighting in Ankara. The participants discussed the importance of **prioritizing a participatory approach** where residents' ideas and concerns are incorporated throughout the process, not just through surface-level public involvement. One participant who is also an expert in water policy and governance emphasized the keyness of public outreach to achieve the stream daylighting goals:

> *"Participation is the cornerstone of ensuring the feasibility and applicability of stream daylighting projects. Without genuine engagement, the effectiveness and sustainability of such initiatives are compromised. My primary concern is the potential weakness in addressing the social dimension of these projects. To counter this, it is essential to involve citizens at every stage—from design to implementation—creating opportunities for their input and fostering a sense of shared ownership. While not every suggestion can be implemented, the process of informing, consulting, and convincing*

stakeholders is critical. In this context, participation is as vital as basic necessities like food and water for the success of such projects."

To achieve that, the participants suggested **fostering a sense of community ownership** and pride in the project through joint celebrations, social media promotion, and emphasizing the collaborative nature of the work. This includes collaboratively designing mechanisms for addressing concerns and gathering feedback during the project's operational stage.

Through the project establishment not only the implementation of the project but also **maintenance process within the public** can foster a sense of shared responsibility among citizenship, rather than relying solely on formal inspection mechanisms.

Furthermore, the participants explained that citizen participation by itself cannot be achieved without convincing and incentivizing key stakeholders like real estate agents to support the project. For them, stream daylighting can provide alternative economic opportunities, which must be discussed through the participation processes.

4.2.3.2 Raising Public Awareness

The action of "Raising Public Awareness" highlights the importance of fostering public understanding throughout the entire process of the project and emphasizes its necessity. It has been noted that such projects are often discussed in the context of "Imar Planları" while it is essential for the public to first **understand the natural systems**, specially regarding water systems, involved. Additionally, recognizing the interconnected functioning of resources and water systems both on the side of public administration and the citizens is crucial for achieving effective ecological restoration.

The public authority participants suggested fostering a sense of ownership within the community. This could involve designing methods to inspire the public to imagine

and anticipate the project's outcomes, encouraging attachment and pride in the initiative. When the community develops such a sense of ownership, successful outcomes similar to other internationally recognized examples can be realized. Challenges such as property ownership issues and the presence of informal housing areas can be addressed more successfully with these initiatives.

4.2.4 Technical and Infrastructural Development

Under the theme of ‘’Technical and Infrastructural Development’’ interview findings suggest that implementing solutions and actions for stream daylighting challenges in Ankara requires two key steps: (i) Rainwater and Sewage Management and (ii) Data Collection and Empowerment.

4.2.4.1 Rainwater and Sewage Management

The participants indicated that, in terms of technical and infrastructural development studies, the most frequently addressed actions were related to rainwater collection and management. They emphasized the need to separate sewage and rainwater systems, explaining that the current combined system leads to the overloading of wastewater treatment facilities during heavy rainfall.

According to the interview results, **the rainwater channels should be designed in an integrated manner with the deculverting projects**. The participants argued that municipalities should have already implemented the rainwater channels as part of urban action plans. While constructing rainwater channels might increase costs, they stressed that such projects are necessary and should be established by municipalities.

It was noted that existing sewage systems had been designed solely to collect wastewater and not rainwater, which exacerbates the problem. The participants further stated that wastewater systems in Türkiye frequently face issues, with treatment facilities having to operate excessively during raining and flooding.

One of the key actions addressed is from a participant from the NGO who is also expert in environmental engineering which stated **the importance of the ‘’BAKAY Project’’ for Ankara**.

> *"The 'BAKAY Project'—the Büyük Ankara Canalization and Rainwater Network, aimed for separating rainwater from domestic waste. Without separating them, you can't uncover the streams. It's been approximately 20–25 years since the project initiated. Ankara has developed in a completely different way according to the Nazım İmar (Master Development) Plan of that time; population densities have changed, and locations have shifted. Therefore, BAKAY needs to be updated and redeveloped. I've also addressed this in past presentations. They are revising the BAKAY Project, but it's been three years. By now, it should have been revised and approved. It is needed to start somewhere, specially for the construction and implementation, it must be begun from the uppermost part of the basin."*

The participants explained that, in order uncover the buried streams, it needs to be ensured that no domestic wastewater is mixed into the river. The channels carry a significant amount of wastewater and domestic waste, that should be treated starting from the upper part of the basin. The domestic wastewater should be prevented from flowing into the river by connecting it to the river through surrounding channels or sewage lines along both sides of the river. Illegal dumping is also a significant threat of domestic waste into waterways, the participant points out that it must be prevented through enforcement and public awareness (See also, Chapter 3.2. Raising Public Awareness).

In addition, participants also emphasized that the operation and maintenance of rainwater systems are critical. They explained that, even with existing rainwater systems, issues such as water accumulation on streets still occur, particularly during rainy seasons, underscoring the need for **regular cleaning of the rainwater grills**.

Without proper maintenance and cleaning and rainwater grills, pollution from asphalt and other debris could still contaminate the rivers.

4.2.4.2 Data Collection and Empowerment

The second key action recommended related to technical and infrastructural development is **improve the availability of infrastructure data** at hand. This includes mapping the underground infrastructure and networks that support the city's operations. Participants emphasize the importance of this goal to gain a comprehensive understanding of the various components, their interactions, and how to effectively utilize resources such as wastewater based on detailed analysis.

4.2.5 Financial Management

Interviews results suggest that the actions to implement to address stream daylighting challenges in the case of Ankara fall into two categories: (i) Conducting Cost Benefit Analysis, and (ii) Securing Diverse Financial Resources.

4.2.5.1 Conducting Cost Benefit Analysis

Conducting a thorough cost-benefit analysis is crucial to demonstrate the financial viability of nature-based solutions.

Participants emphasize the need of comprehensive cost-benefit analysis for the project, as its benefits may differ from those of traditional grey infrastructure. One participant from the NGO interview group, highlighted the norms of the feasibility study, and the **cost-benefit analysis should be innovated and renewed accounting for the social and environmental benefits** of the project area. Some participants also stated that the indirect benefits of the study if converted to economic measures can be helpful to persuade the decision makers.

A public authority participant explained that, if uncovering streams can provide an urban identity to the city, the public authorities may compensate the costs without over-focusing the immediate benefits. Because such services are like urban services like public transportation, recreational, education, or health care the state should provide free of charge. They have cumulative benefits that will be seen over the years, rather than direct financial returns. Such as affecting human mobility, contributing to environmental health, attracting tourists, or improving productivity through recreational purposes which indirectly contribute to the economy. Another public authority highlighted the importance of cost-benefit analysis because the project implementation may harm the order of the city in the short term which necessitates ensuring long-term gains outweigh short-term costs. This reflects the positive perspective of the public authorities as well as that the potential indirect economic benefits should be accounted for in detail analysis studies for providing the institutions and decision-makers.

4.2.5.2 Securing Diverse Financial Resources

Based on the interview analysis regarding actions to deculverting in Ankara, there is a recognized need to secure diverse financial resources to compensate limited resources and budget. Participants highlighted the need for securing diverse financial resources, including international funding and support from various government agencies, and the need to gain that as a practice to collaborate.

Local governments must actively seek external funding to supplement their own resources when implementing such projects. Additionally, participants emphasized the necessity of **securing international financial resources** alongside domestic sources, such as ministry funds and EU funds.

4.2.6 Institutional Capacity and Governance

The interview results reveal the importance of strengthening institutional capacity and governance for water-related projects, which can be explained under three sub-categories: (i) Increasing the Transparency and Accountability of Institutions, (ii) Improving the Participatory Processes of Institutions and (iii) Strengthening Institutional Human Resources Capacity.

4.2.6.1 Increasing the Transparency and Accountability of Institutions

The participant highlighted the need for actions to ensure transparency and accountability. The public should be able to access accurate information. In that way, the public and the administrations can resolve implementation issues and public reactions due to the stream daylighting projects. This can particularly be helpful dealing with the concerns about the land and property issues, and understanding the public satisfaction related to the results of the project.

4.2.6.2 Improving the Participatory Processes of Institutions

The participants discussed that successful implementation of a potential daylighting depends on a dedicated project team that actively engages public institutions and the public throughout the process, using diverse methods to ensure broad participation.

For improving the participatory processes, there is a need for institutions requiring coordinated efforts across agencies, specially addressing conflicts over jurisdictions and ineffective legal regulations. This is a challenging but important factor, requiring institutions to continuously learn, apply, and refine their participatory approaches through feedback and evaluation.

4.2.6.3 Strengthening Institutional Human Resources Capacity

In the context of strengthening the institutional capacity strengthening the human resources is crucial for effectively addressing water-related issues, which were discussed critically by the participants.

Enhancing the technical and human resource capacities within the municipality is also essential before undertaking such initiatives in uncovering the streams, especially regarding technical and engineering expertise in nature-based solution practices.

Also, to secure financial resources, particularly from international actors, it is important for the municipalities to identify the most suitable funding sources, effectively communicate their projects, and transparently report on the utilization of the funds received. This involves **establishing a strong international relations department** coordinating and managing these processes.

4.2.7 Legal Regulations

‘’Legal Regulations’’ actions categorized under two-sub categories: (i) Protecting and Preserving Streams , (ii) Strategic Decisions in Planning Processes.

4.2.7.1 Protecting and Preserving Streams

The key legal actions proposed by the participants focus on legislative strategies to address issues related to river rehabilitation and conservation. Rather than uncovering the streams, it was suggested preserving the current streams. One participant, who is an expert in environmental engineering, highlighted the importance of **prioritizing the protection of clean and unpolluted streams**, stating:

"The easiest thing to do is to preserve the clean streams. Once a stream is polluted, it's uncertain whether it can be restored, how it will be opened, or what it will cost. Instead of engaging in utopian ideas, we should first focus on preserving what currently exists. In my opinion, the top priority as a strategy and legislation should have been to avoid polluting the streams that are still unpolluted."

The participant strongly emphasized that preserving streams' natural states should be the primary focus of any strategic approach in the water governance. Furthermore, it was discussed that, to conserve the streams and establish deculverting projects, there is a need to conduct **comprehensive studies for legislative harmonization**.

4.2.7.2 Strategic Decisions in Planning Processes

The participants outlined how strategic upper-scale decisions, such as those in the urban master plan in 1/100.000, can shape and streamline the planning and implementation processes. This can clear the way for creating new urban renewal spaces and a blue-green corridor.

Lastly, it was emphasized that the conflict over jurisdictions in terms of maintenance and monitoring of the project area is confusing and time-consuming. Therefore, assigning full authority to the responsible institution can ease the planning and implementation processes.

CHAPTER 5

DISCUSSION

5.1 Understanding Global Stream Daylighting Practices

The first sub-research question of the thesis was **‘’What are the contemporary global strategies and solutions for stream daylighting in the face of climate change?’’**. A descriptive research approach was employed to gain a comprehensive understanding of stream daylighting projects. This involved the systematic thematic analysis of 19 project-based case studies from diverse geographical and cultural contexts. The analysis examines the constraints that hinder global deculverting initiatives, identifies enablers that serve as drivers, and explores actions that constitute potential solutions within the context of stream daylighting case studies.

The thematical analysis reveals classification of (i) drivers, (ii) challenges and (iii) actions derived from project-based case studies, respectively.

Firstly, under the thematic classification of drivers, the most frequently mentioned factors in stream daylighting projects highlight universal and shared challenges associated with urbanization and stream burial. Specifically, examining the three most frequently cited themes—**Environmental Restoration and Protection** (40%) highlights the intensification of shared problems stemming from stream burial across various urban contexts and the increasing necessity to address these issues at a localized level. Under this overarching theme, the sub-drivers **Flood Mitigation** (19%), **Ecosystem Revitalization** (12%), and **Water Quality Improvement and Pollution Reduction** (9%) emerge as the most recurrent sub-themes in the driver too. These findings underscore the common urban problems caused by stream burial, such as increased flood risks, ecological degradation, and water pollution, that require immediate attention and targeted interventions.

Additionally, other sub-themes that hold equal importance to the third most-cited sub-theme include **Public Awareness and Engagement** (9%), **National Legislative Framework** (9%), and **Social Well-Being** (9%). These sub-themes reveal critical insights into the dynamics driving stream daylighting projects. **Public Awareness and Engagement** reflects the significant role of an active and environmentally conscious public, alongside governmental motivation, in driving water and environmental protection efforts. **National Legislative Framework** highlights the importance of **top-down approaches**, where national laws provide an enabling environment for stream restoration and daylighting projects. Such frameworks facilitate the integrated management of water resources and environmental protection, encompassing aspects such as flood mitigation and ecological improvement. **Social Well-Being** points to the motivation for enhancing recreational opportunities within deculverted streams, contributing to public well-being, particularly in urban areas.

Secondly, under the thematic classification of the challenges, the findings from the existed literature were less extensive compared to the drivers and actions in case studies. However, the most prominent and frequently mentioned challenge in stream daylighting projects was **stakeholder engagement and collaboration** (34.0%). This challenge far exceeds other barriers in significance, emphasizing its criticality in the success of such projects. This demonstrates that the lack of participatory processes, inadequate public support, and limited stakeholder involvement in decision-making are the most common and substantial barriers to stream daylighting efforts.

Thirdly, under the thematic classification of actions, the most emphasized actions include **active public engagement** (12.9%), **educating communities** (11.4%), and **fostering collaboration among authorities** (9.8%). This may directly address the significant challenge of **stakeholder engagement and collaboration** (34%). Successful case studies highlight the importance of early and active involvement of both the public and stakeholders, which enhances project acceptance and integration while delivering multiple benefits. Additionally, many projects integrate the deculverting project with **Development of Integrated Urban Plans** (9.1%),

incorporating local master plans and large-scale initiatives. These integrated approaches provide a structured framework for tackling complex urban issues discussed under the drivers and challenges of stream daylighting.

On the other hand, the relatively low emphasis on actions related to **Environmental Restoration** (12.9%) raises concerns about the adequacy of efforts targeting '**Environmental Restoration and Protection'**, which often serve as the primary drivers of stream daylighting projects. Simply uncovering streams is insufficient to rehabilitate the ecological damage caused by past interventions in these areas. This distinction may suggest potential gaps in research, implementation or documentation addressing ecological stream restoration methods in stream daylighting case studies. There is a clear need for more extensive evidence, detailed studies, and actionable strategies that address the ecological problems on the study area and restoration methods.

5.2 Elaboration of Findings on Stream Daylighting in Ankara

5.2.1 The Research Finding on the Challenges to Stream Daylighting in Ankara

Employing an exploratory research approach, the second sub-research question of the thesis was: "How do the representatives of local authorities, NGOs, and academia perceive the challenges to stream daylighting?''

The results of the content analysis of in-depth interviews revealed key challenges and highlighted the perception of stakeholders. While some themes were mentioned more frequently, others, though less frequent, revealed unique aspects of the Ankara case, which are further discussed in next chapter. These findings provide valuable insights into the complexities of stream daylighting in Ankara and the factors impeding its implementation. Furthermore, the frequencies should not necessarily be

interpreted as indicating the most important challenges, but rather the barriers that are most well-known and emphasized by involved participants in this research.

Across all interviews, "**Project Management and Implementation Issues**" was the most commonly identified barrier to stream daylighting, accounting for 27.2% of the total mentions across all contents. This theme consists of the critical challenges of insufficient social management, poor planning and programming, inadequate physical design in stream daylighting projects and lack of project monitoring and supervision. **Social management**, encompassing responsibilities like public communication, minimizing disruptions, and securing support, emerged as a key aspect of project management. **Poor planning and programming** were noted to cause serious issues, compounded by physical design challenges such as limited space, failure to use local species, and ecological restoration shortcomings. Additionally, participants stressed the risks of inadequate maintenance, supervision, and operation, all of which threaten the long-term sustainability of project areas.

In terms of the percentage of sub-themes mentioned, the most mentioned challenge is the '**'Limited Financial Resources (12.5%)''**. In the case of Ankara, according the perception of the stakeholders, stream daylighting projects may face significant financial challenges due to high investment and land acquisition costs, insufficient municipal budgets, and economic volatility. Associated with the economical hindrances securing international funding is restricted with the jurisdictional uncertainties, inadequate environmental and social impact reports, and public resistance to repayable loans. Urban centers like Ankara face additional burdens with costly expropriations and resident relocations. In addition, the national budgets prioritize present basic needs, leaving the city vulnerable to the possible flooding and other stream burial related risks.

The analysis highlights that the second primary challenge in managing and implementing stream daylighting projects is the "Risks of Lack of Social Management." Rather than assuming present challenges, this theme reveals a concern about the lack of effective social management in urban planning and water

governance projects by the stakeholders. The theme encompasses the lack of disseminating project information, minimizing urban disruptions, gaining public support, and managing emotional reactions from institutions and citizens. Without public persuasion, societal resistance and crises may arise, particularly concerning expropriation and urban life disruptions like traffic changes, construction delays, and relocations. There is also a strong emphasis on the importance of media in fostering public understanding and mitigating negative perceptions. The project has multi-year construction timeline, and there is a need for clear communication to maintain public motivation and awareness of long-term project benefits. Failure to address these social dimensions is a great risk that could undermine the project's success.

The third most highlighted challenge, the Ankara case is the "**Lack of Scientific, Technical, and Project Management Capacity in Institutions**" (7.2%). The lack of scientific, technical, and project management capacity within institutions presents significant challenges to implementing stream daylighting projects. Key issues include inadequate technical expertise and decision-makers, poorly planned interventions that worsen stream conditions, and the absence of standardized practices for ecological restoration and stream daylighting in Türkiye. Institutional decision-making is often overly focused on economic feasibility, neglecting environmental and social benefits, while outdated technologies and methods fail to address modern challenges like climate change. Additionally, the stakeholders outlined that the central administrations lack the capacity to oversee long-term project sustainability, and institutions struggle with multidisciplinary project demands and preparing comprehensive technical guidelines. Financial management in institutions is another critical gap, which also overlaps with the concerns over the ''Limited Financial Resources''. The limited expertise in securing, managing, and utilizing funding from domestic and international sources undermines project effectiveness more than financial resource constraints.

5.2.2 The Research Finding on the Actions for Stream Daylighting in Ankara

The third sub-research question of the thesis was: “What strategies can experts and relevant stakeholders employ to address identified challenges?’’

In parallel with the most common identified challenges which were “Project Management and Implementation Issues’’ the most identified actions are related with the "Project Management and Planning’’ with the percentage of 38.8%. Under the theme of **Project Management and Planning**, participants identified three key priorities for stream daylighting projects in Ankara: (ii) **Cross-Scale Planning and Phasing**, (ii) **Communication and Dissemination**, and (iii) **Conducting Feasibility Studies**. Under the suggestions, there is the need of cross-scale planning and comprehensive approaches, such as aligning master plans with detailed sub-scale designs, addressing watershed-wide issues like pollution, and ensuring long-term water resource sustainability. The participants recommended the pilot projects to demonstrate benefits and build public trust. Effective communication and dissemination were highlighted to engage diverse stakeholders, including the private sector, NGOs, and communities, through accessible messaging, participative workshops, and visualization tools. This can foster support, project ownership, and confidence in green infrastructure as a viable alternative between the public and the project stakeholders. Lastly, conducting multidisciplinary feasibility studies with thorough data collection and analysis was emphasized for a healthier project analysis and development process, ensuring long-term outcomes.

In terms of the percentage of sub-themes mentioned, the most mentioned action is the “Cross-Scale Planning and Phasing (19.0%)’’. This theme is reflected upon the challenge of ‘’Planning and Programming’’ which participants discussed the risk of inadequate planning and programming. In ‘’Cross-Scale Planning and Phasing’’ action, it was suggested to develop comprehensive plans for the stream daylighting, which are in align with the upper-scale planning starting from the watershed scale. They mentioned the necessity of ensuring the sustainability of stream water

resources sustainability. Furthermore, as a strategy it was suggested implementing small-scale pilots can be a preliminary step to persuade the stakeholders of the potential success of the daylighting project.

The second most mentioned sub-themes in the actions is the "Communication and Dissemination" (11.6%). This theme directly reflects the need of addressing the challenge of "Risks of Lack of Social Management''. This interrelation shows the critical need for effective communication both between the stakeholders in the project process and informing the public with interactive methods.

The third most mentioned theme in the actions is "Sustainable Urban and Landscape Design" (10.7%). This theme is mainly reflected upon the challenge theme of ''Risks Related to the Physical Design of the Project'' in which participants criticized the limited space availability in the urban areas of Ankara, the failure in landscape designs of the public projects utilizing functional and ecological design. The participants emphasized the necessity of reconnecting people with the water, with a focus on Ankara's unique steppe ecosystem and sustainable landscape design. The significance of designing a multifunctional recreational area while integrating water use into a self-sustaining cycle within the basin.

5.3 Synthesis of Case Studies and Research Findings on Barriers to Stream Daylighting

This section compares the literature review on stream daylighting challenges with the research findings from the Ankara Case, highlighting (i) overlapping issues, (ii) gaps, and (iii) unique aspects in the context of each sub-theme.

Table 5.1 Comparison of 'Urban Project Management' and 'Risks of Social Management of the Project' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Project Management	Risks of Social Management of the Project	**Overlap:** Public Communication Challenges
		Unique: Ankara case emphasizes public persuasion and community engagement, particularly in managing societal resistance to disruptions like expropriation process or construction delays.

The consistency between the research findings and the literature suggests that the challenge of public communication is a global concern across contexts in daylighting projects. While the literature review focuses on the lack of dissemination gaps and their impact on community recognition, Ankara case emphasizes the role of media in shaping public perception and support.

This study contributed particularly to the barrier of managing societal resistance to disruptions like the expropriation process or construction delays, as a context-specific challenge unique to Ankara which has not been extensively explored in the reviewed literature.

Table 5.2 Comparison of the themes of 'Urban Project Management' and 'Planning and Programming'

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Project Management	Planning and Programming	**Overlap:** Both themes address the impact of the poor past decision and plannings as a challenge.
		Gap: The literature review discusses the impact of overlapping projects and how they complicate daylighting efforts.
		Unique Aspects: Ankara case highlights risks of corruption and gentrification, emphasizing the need for transparency in project management. Stresses prioritization of critical issues to ensure resource efficiency, which is not directly discussed in literature review.

The alignment of the research findings with existing literature highlights that the challenges posed by past poor planning decisions present significant obstacles to stream daylighting. Poor past planning decisions are highlighted as a persistent obstacle, often requiring phased approaches to correct earlier mistakes.

The Ankara case reveals that overlapping urban projects are not considered a significant factor by the participants, pointing to a gap in their perceived importance.

The contribution of this thesis is the recognition of risks of corruption and gentrification as a context-specific challenge unique to Ankara. This highlights the public concerns about corruption, gentrification, and how these risks undermine the fairness and equity of a stream daylighting project.

Table 5.3 Comparison of the 'Urban Density and Infrastructure Constraints' and 'Risks Related to the Physical Design of the Project' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Density and Infrastructure Constraints	Risks Related to the Physical Design of the Project	Overlap: Both address the challenges of space and design in stream daylighting projects, particularly in dense urban environments.
		Gap: Literature review provides more detailed hydrological challenges related to channel geometry and floodplain restoration, illustrated through international case studies.
		Unique: Ankara case broadens the focus in the inappropriate landscaping practices, and poor design processes, which were not discussed in the case studies review.

The findings align with the existing knowledge, reinforcing the importance of space and design challenges in stream daylighting projects, particularly in dense urban environments.

While spatial and hydrological constraints related to design – such as channel geometry, flood risks, and erosion- are emphasized in detail in the literature, these factors are only weakly addressed by the participants in the Ankara research study.

In this regard, the contribution of this thesis lies in broadening the local focus in the case of Ankara, particularly in critiquing inappropriate landscaping practices and poor design processes.

Table 5.4 Comparison of the themes of 'Urban Project Management' and 'Post Project Monitoring'

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Project Management	Post-Project Monitoring	**Overlap:** - Maintenance and Monitoring Challenges - Pollution and Environmental Risks - Lack of Community Engagement
		Unique: Ankara case focuses on specific post-completion challenges, such as the pollution of streams, waste disposal, and lack of community ownership.

These research findings results are consistent with the literature, emphasizing the critical role of regular maintenance and monitoring after the completion of daylighting projects. Both literature and the research findings highlight environmental pollution as a significant post-completion issue including the control of the water quality. In that sense, both the literature review and the research findings mention the importance of community involvement for the long-term success of the project. While in literature review it was highlighted how can poorly planning decisions (e.g., Tibbetts Brook) result in inaccessible areas and segregated neighborhoods (Molnar, 2022), the participants from the Ankara case interview describes how lack of community ownership led to the failure of a recreational project in İstanbul, illustrating the risks.

This study contributes to the field by offering new insights into specific post-completion risks, such as the risk of pollution of streams due to the public waste disposal, and lack of developing communal ownership. It specifically emphasizes the importance of communication and public engagement before and after project completion to ensure its sustainability.

Table 5.5 Comparison of 'Economic Interest Management' and the sub-themes under the 'Financial Problems'

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Economic Interest Management	- Limited Financial Resources - Decision-Makers' Investment Approach and Persuasion Processes - Project Costs and Unpredictability	**Overlap:** - Funding Challenges - Economic Trade-offs - Cost Management Constraints
		Unique: The Ankara case reveals unpredictability in project costs and securing international funding.

The research findings validate the existing knowledge in literature in terms of funding challenges, economic trade-offs, and cost management challenges in stream daylighting projects. Both themes emphasize difficulties in acquiring sufficient funds for the project. Both address the economic trade-offs, about the balance between project benefits and financial viability. Both recognize the risk of cost unpredictability during construction and its impact on project timelines and success.

This research made a contribution to the recognition of unpredictability in project costs as a context-specific challenge unique to Ankara. These challenges explain the concerns over the other challenges such as unexpected infrastructure issues, unforeseen cost increases (ex. Economic crises), and uncertainty of sponsorship and support mechanisms. In addition, the Ankara case, particularly faces the challenge of securing international funding due to jurisdictional uncertainty.

Table 5.6 Comparison of ‘Urban Density and Infrastructure Constraints’ and ‘Construction Phase Issues’ Themes

Sub-Themes (Case Studies Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Density and Infrastructure Constraints	Construction Phase Issues	Overlap: Both address the challenges posed by urban density and complex infrastructure in city centers, with an emphasis on how these factors complicate stream daylighting projects.
		Unique: Ankara case focusses unforeseen infrastructure such as archeological heritages that can be damaged during the excavations.

The consistency between the case studies review and research findings suggests that the challenges posed by urban density and complex infrastructure in city centers, and how these factors complicate stream daylighting projects is a global concern across contexts. In addition, inadequate or outdated sewer and drainage systems are recurring issues that affect construction feasibility in deculverting projects.

A distinctive contribution of this research is the recognition of unforeseen infrastructure as a context-specific challenge unique to Ankara. Ankara case focusses ‘’unforeseen infrastructure’’ such as archeological heritages that can be damaged during the excavations. This unforeseen infrastructure also due to the lack of infrastructural mapping. In addition, Ankara-specific geological and infrastructure risks, including unique challenges like "Ankara Clay" and the unpredictability of archaeological discoveries. It also provides a detailed view of how urban density complicates technical execution.

Table 5.7 Comparison of 'Urban Density and Infrastructure Constraints' and 'Technical and Infrastructural Problems' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Density and Infrastructure Constraints	Technical and Infrastructural Problems	Overlap: Both highlight problems with outdated or inadequate drainage and sewer systems, which increase flooding risks and hinder effective project implementation. Both themes address how existing infrastructure and poor planning affect the feasibility of stream daylighting projects.
		Unique: Ankara case emphasizes foundational systemic issues, such as incomplete data on underground utilities, contamination of streams, and fragmented management of privatized services.

The case study review and Ankara case results are consistent in outdated or inadequate drainage and sewer systems, which increase flooding risks and hinder effective project implementation and how existing infrastructure and poor planning affect the feasibility of stream daylighting.

This thesis introduces a new perspective by identifying foundational systemic issues in technical and infrastructural challenges to stream daylighting. Such as incomplete data on underground utilities and fragmented management of privatized services hindering the project in water restoration projects in the case of Ankara.

Table 5.8 Comparison of 'Urban Project Management' and 'Lack of Scientific, Technical, and Project Management Capacity in Institutions' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Urban Project Management	Lack of Scientific, Technical, and Project Management Capacity in Institutions	**Overlap:** Outdated Approaches
		Unique: Ankara case delves into systemic limitations, such as a lack of expertise, structured practices, and financial constraints, which hinder effective implementation.

The alignment of these findings with existing literature indicates that **outdated approaches concerns** are globally relevant issues in stream daylighting urban project management. Both the literature and research findings discuss the challenges of reliance on outdated technologies and methodologies as a barrier to effective daylighting.

A contribution of this study is the recognition of how institutions lack the expertise to establish structured practices as a context-specific challenge unique to Ankara. In the case of Ankara, institutions struggle to assess project feasibility, prepare specific guidelines for stream restoration, and manage complex multidisciplinary initiatives. Limited knowledge of financial partnerships, inadequate monitoring capacity, and insufficient human resources may further complicate project planning and execution.

Table 5.9 Comparison of 'Environmental Complications During the Construction' and 'The Risk of Public Health Issues' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Environmental Complications During the Construction	The Risk of Public Health Issues	**Overlap:** Pollution Risks
		Gap: Literature review discusses invasive species as a barrier to restoring natural ecosystem.
		Unique: Ankara case highlights human health risks that could arise from inadequate planning.

Both the literature review and the Ankara case research discuss the impact of pollution on the environment.

Invasive species restricting the restoring of the natural ecosystem to the streams while emphasized in existing literature, was not mentioned by the research participants in this study.

Another contribution of this research is its identification of human health risks concerned by the participants of the Ankara case research. The participants concerned over the historical context for stream coverage to address health risks, emphasizing the need for proper planning to avoid reintroducing these issues.

Table 5.10 Comparison of 'Stakeholder Engagement and Collaboration' and 'Social Resistance and Concept of Ownership' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Stakeholder Engagement and Collaboration	Social Resistance and Concept of Ownership	**Overlap:** - Public Resistance - Lack of Awareness
		Unique: Ankara case focuses on deeply ingrained cultural issues, such as the societal attachment to private property ownership in Türkiye, which complicates expropriation and relocation. It also discusses the psychological barriers to change.

Both literature and this research identify resistance from local communities as a major challenge. Both emphasize the lack of public understanding as a barrier.

An important finding of this study is the identification of cultural attachment to property ownership as a challenge specific to the context of Ankara. This reflects deeply ingrained cultural issues, which complicate expropriation and relocation. In addition to that, it discusses the fear of innovation and preference for traditional solutions, illustrating the psychological barriers to change.

Table 5.11 Comparison of 'Stakeholder Engagement and Collaboration' and the 'Problems Related to Participation Processes' Themes

Sub-Themes (Literature Review)	**Sub-Themes (Ankara Case)**	**Overlap/Gap/Unique Aspect**
Stakeholder Engagement and Collaboration	- Stakeholder Engagement and Communication - Public Participation and Awareness	**Overlap:** - Communication and Coordination Problems - Public Involvement Challenges
		Unique: - Lack of knowledge and training within institutions - Lack of cross-disciplinary communication and decision-making

The parallels between these research findings and literature underscore the ongoing relevance of communication and public involvement challenges across various contexts. Both the literature and the case study of Ankara highlight the challenges related to communication and coordination among stakeholders, as well as the differing goals they pursue. Furthermore, both sources acknowledge public involvement challenges, emphasizing that public resistance can impede the progression of projects.

This study, however, brings a perspective by identifying ‘a lack of awareness about participatory processes’ as a context-dependent issue specific to Ankara. The Ankara case particularly emphasizes a lack of awareness about participatory processes and their associated benefits, coupled with difficulties in engaging stakeholders directly affected by projects. In addition, the research findings draws attention to the insufficient knowledge and training within institutions regarding participatory processes, suggesting that decision-makers are inadequately prepared to manage such initiatives. In contrast, literature mostly focuses on enhancing cross-disciplinary

communication and decision-making, rather than addressing these local institutional challenges.

To conclude, the remaining sub-themes from the Ankara case study reveal localized challenges as barriers to stream daylighting, which is a key contribution of this research as the following:

- 'Political Instability,' which poses significant challenges for local governments in executing long-term infrastructure projects, particularly due to election cycles that occur every five years. Elected officials may be discouraged from pursuing ambitious, multi-year infrastructure initiatives, viewing them as risky because they might be left unfinished if not completed within a single term. This often results in unimplemented plans and the potential accumulation of long-term municipal debt in Türkiye. Additionally, political polarization can lead to strong opposition against projects, even those that would benefit the broader public, further hindering their successful implementation.

- 'The Implementation of Regulations' causing several challenges, primarily due to inconsistencies between legislation and practice. Policy discussions often do not translate into actionable or enforceable solutions, leaving plans unrealized. Current regulations lack guidance on innovative practices like rainwater and greywater management and fail to account for local context, leading to unintended consequences. Additionally, conflicting legislation between sectors such as agriculture, forestry, and water management complicate and risk projects like stream daylighting. The expropriation law also creates delays, as it involves lengthy procedures for land acquisition and compensation, further hindered by bureaucratic inefficiencies. These legal and administrative hurdles significantly obstruct the timely and effective implementation.

- ‘The Gaps in Legislation’ pose significant challenges, particularly the lack of coordination and alignment between sectoral laws that affect flood management and river restoration efforts. Additionally, the absence of a comprehensive national flood law and insufficient legal authority for public authorities to undertake expropriation hinder effective implementation of related projects.

- Lastly, ‘Problems in Governance and Decision-Making Processes of Institutions’ causes challenges such as unclear institutional roles, overlapping jurisdictions, and conflicting authority boundaries, particularly between central and local authorities. For example, flood management responsibilities in Türkiye are shared between the State Hydraulic Works (DSİ) and municipalities, creating delays due to conflicts over expropriation authority. Further complications arise from jurisdictional conflicts between metropolitan and district municipalities and the lack of clear responsibility for stream daylighting projects. Additionally, convincing high-level decision-makers to approve long-term projects like stream daylighting is difficult due to limited funding, competing priorities, and skepticism about their feasibility, resulting in delayed actions, undermined trust, and missed opportunities.

CHAPTER 6

CONCLUSION

This research investigated the challenges to establishing the practice of stream daylighting in Ankara in the face of climate change. To do that, it posed three sub-research questions.

Based on the first sub-research question, descriptive research revealed an understanding of global stream daylighting projects under the classifications of drivers, challenges, and actions. This classification provided a structured framework to analyze the interconnected factors influencing stream daylighting and address diverse barriers.

As it was revealed in Chapter 5.1., the existing literature on global examples demonstrates that the primary drivers behind implementing a stream daylighting project are environmental restoration and protection. Under this, the projects primarily aimed for flood mitigation, followed by ecosystem revitalization, and then water quality improvement and pollution reduction. These priorities reflect the underlying reasons for daylighting projects, addressing the negative impacts of stream burial in the urban environment.

Additionally, aspects such as an active and environmentally conscious public, the pressure of national legislation, and motivation for enhancing recreational opportunities within de-culverted streams highlight the significance of public and governmental roles in enabling daylighting projects.

In terms of daylighting challenges, the most common and substantial barriers to stream daylighting efforts was the lack of participatory approaches and inclusive decision-making. This highlights that the absence of participatory processes, insufficient public support, and restricted stakeholder involvement in decision-making are among the most prevalent and significant obstacles to stream daylighting efforts.

The actions to address these challenges are centered on the methods of fostering public engagement, educating the communities and increasing the collaboration among the responsible authorities in align with the barriers over the lack of participatory processes. The results of various actions demonstrate that involving the public directly in decision-making processes, planning, and hands-on project activities fosters a sense of ownership over the project and helps to sustain the project area. Multi-level stakeholder collaboration plays a crucial role in this by providing support in several ways, such as allocating budgets, ensuring public acceptance, disseminating project information, and securing human resources needed for the project. Additionally, innovative approaches to educating people about daylighting projects can raise awareness and contribute to long-term sustainability. Furthermore, to these actions in the global examples, successful studies include comprehensive and integrated urban plans c incorporating local master plans to large-scale initiatives addressing diverse challenges through detailed spatial planning.

However, review of the literature revealed gaps in addressing ecological restoration within the context of stream daylighting actions. As Khirfan et al. (2020c) emphasized, there has been a limited focus on the ecological aspects of stream daylighting. This study affirms the lack in addressing ecological restoration techniques and the ecological impacts on the area after the project concludes. Therefore, it is recommended to enhance the context of the stream daylighting case studies by improving and giving more details addressing nature-based solutions in a solicit and proven way, demonstrating the ecological functionality. It should also be adaptable to various local conditions. This approach is similar to The River Restoration Centre (RRC) group in UK who provides an open

platform in river restoration of technical advice and assessment, training and guidance and knowledge exchange in national level.

The second and third sub-research questions identified the perceptions of experts in three stakeholder groups: public authority, academia, and NGOs. The research was conducted regarding the challenges and actions associated with stream daylighting through exploratory research.

Among the identified challenges, key difficulties include issues related to project execution, limited financial resources, and insufficient institutional capacity. In terms of project execution challenges, the most frequently mentioned challenges were, covering concerns over poor planning, inadequate physical design, and after the project completion the lack of project monitoring. The experts highlighted the difficulties in managing social aspects in project executions, due to ineffective communication within the public and institutions, which can disrupt project success. In the context of financial constraints, the experts highlighted challenging factors like limited municipal budgets, compensating expropriation costs, and economic volatility that may hinder stream daylighting efforts. The experts also noted restricted access to international funding due to jurisdictional uncertainties and inadequate impact assessments. Regarding the insufficient institutional capacity, there were concerns about the absence of technical expertise and standardized practices within institutions that can further complicate implementation. The experts observed that outdated traditional methods in engineering can cause a daylighting project to fail in addressing modern challenges like climate change. Notably, experts stressed the institutions lacking multidisciplinary approaches in projects. In the context of institutional capacity, the experts notify that this issue is closely related with the inefficient financial management including employing the qualified human resources to achieve a successful water infrastructure project.

Furthermore, this research makes several contributions by highlighting unique, context-specific challenges to stream daylighting in Ankara.

Experts reported several feasibility risks related to the construction process. These include complications with archaeological heritage, difficulties in relocating infrastructure due to poor mapping, and unique geological challenges posed by the "Ankara Clay", which could disrupt construction. Specifically, these factors could complicate the technical execution of infrastructure projects in the city center. Additionally, the thesis identifies systemic issues stemming from incomplete data on underground utilities, which is compounded by the fragmented management of privatized services. This situation hampers the integrity of water infrastructure and restoration projects. The findings also emphasize the need to assess the health risks associated with Ankara's streams.

In terms of financial management, unique to the Ankara case, financial unpredictability, including unforeseen cost increases, jurisdictional uncertainty, and difficulties in securing international funding, were addressed as exacerbating the challenges to stream daylighting. The experts also described concerns over corruption and gentrification, potentially undermining the equity and fairness of a daylighting initiative.

The study also sheds light on institutional limitations, to manage a daylighting project due to inadequate expertise in assessing feasibility, preparing guidelines, and managing urban and infrastructural projects in an interdisciplinary manner. Notably, insufficient awareness and training around participatory processes that can hinder effective stakeholder engagement.

Lastly, societal barriers were highlighted, in cultural attachment to property ownership, and psychological resistance to innovation revealing deeply ingrained local challenges. The interviews revealed several critical issues in relation to the stream daylighting barriers. Political cycles and polarization in Türkiye discourage long-term infrastructure projects, leading to unfinished initiatives, and unimplemented plans. Following this, in terms of policy and practice there are serious inconsistencies negatively impacting an effective urban project execution in Türkiye. This is mainly due to the overlapping jurisdictions and unclear roles within

the undermining trust and effectiveness of the institutions. These results are in alignment with the findings of Avcı (2021) and Kocabaş (2024) discussing the key problems in water management in Türkiye at a national level as it was discussed in chapter 2.4.1. Avcı (2021) mainly criticizes the lack of a unified water law at the national level that can enable different institutions to regulate together and ensure cross-sectoral coordination in water management. Kocabaş(2024) explains water sensitive planning and design approaches within the existing legal and administrative structure are currently suffering. This thesis study affirmed the mentioned problems particularly the gap between practice and legislation through participatory research.

The interview provided valuable content in the findings. The experts and relevant stakeholders also employed key actions addressing the identified challenges, highlighting areas for priority interventions.

Among the findings of the perception of actions, the most identified actions focused on project management and planning. This critically addresses the need to refer to the issues related to urban project implementations. Additionally, mostly it was referred to prioritizing cross-scale planning and aligning master plans with watershed-level designs to address pollution and ensure water sustainability. In addition, the need to build effective communication was highlighted for engaging stakeholders and the public. This interrelation shows the critical need for effective communication both between the stakeholders in the project process and informing the public with interactive methods. Lastly, in the context of perception of actions the research revelated the importance of addressing physical design challenges by reconnecting people with water through sustainable designs that incorporate Ankara's unique steppe ecosystem, create multifunctional recreational areas, and establish a self-sustaining water cycle within the basin.

Notably, this study was limited in providing a more nuanced differentiation of perspectives among expert groups. A greater representation of academics and NGO members was needed for a more detailed contextual analysis, as this search predominantly reflected the perspective of public experts.

In conclusion, given the exploratory nature of this study, it enables the generation of new discussions. Future studies could focus on several key topics related to the city of Ankara. These include the interchangeable barriers that arise in different urban contexts within Ankara, particularly in relation to the distinctions between urban and rural applications of stream daylighting and restoration efforts. They could also address strategies for bridging gaps in infrastructural data to effectively implement deculverting initiatives, as well as explore collaborative and participatory planning approaches aimed at achieving successful stream daylighting or stream restoration efforts. Additionally, financial feasibility of the ecological restoration techniques and nature-based solutions tailored to the specific needs of Ankara's streams could be investigated. Potential health risks are associated with streams in Ankara and their implications would be significant research addressing critical concerns over public health.

This thesis contributes to the growing body of knowledge on stream daylighting by highlighting the unique challenges and strategies identified in the Ankara case. By bridging global insights with local contexts, this research provides actionable recommendations for stakeholders and emphasizes the importance of integrating ecological and urban considerations into daylighting projects. It can serve as a preliminary assessment of feasibility, identifying key gaps and actionable steps necessary for practical implementation of the stream restoration efforts. The findings can be used by public institutions and contribute to the development of climate change mitigation strategies in urban planning projects.

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APPENDICES

A. Semi-Structured In Depth Interview Questionnaire

1. Kent merkezinde veya yüksek yoğunlukta bir bölgede çalışmanın getireceği spesifik zorluklar ne olabilir?

2. Kentsel altyapı açısından düşündüğümüzde sizce gün yüzüne çıkarma eylemi gerçekleştirildiğinde karşılaşacağımız problemler nelerdir?

3. Sizce böyle bir proje yapılma dahilinde, projenin fizibilitesi ve uygulanabilirliği hakkında ne gibi endişeler doğabilir?

4. Mevzuat bağlamında ne tür problemler yaşanabilir?

5. Böyle bir proje uygulandıktan sonra sizce proje alanının bakımı ve yaşatılması ile ilgili ne gibi zorluklar yaşanabilir?

6. Toplumsal açıdan ne gibi sorunlar yaşanabilir?

7. Finansal kaynak sağlama sürecindeki potansiyel zorluklar nelerdir?

B. Case Study Thematical Analysis, Stream Daylighting Drivers

MAIN DRIVERS	Sub-Themes Drivers Content Groups	sub- themes %	main themes %
Environmental Restoration and Protection	Flooding Mitigation	19%	40%
	Ecosystem Revitalization	12%	
	Water Quality Improvement and Pollution Reduction	9%	
Community Engagement and Cultural Identity	Public Awareness and Engagement	9%	16%
	Cultural and Historic Conservation	7%	
Institutional Initiatives and Policy Support	Transnational Obligatory Agreements	3%	13%
	National Legislative Framework	9%	
	Local Action Plan	1%	
Public Health and Well-Being	Public Health and Safety	4%	13%
	Social Well-being	9%	
Resilient Infrastructure	Upgrading Infrastructure Capacity	6%	9%
	Renewal of Infrastructure	3%	
Economic Development	Tackling Economic Decline in Downtown Areas	3%	9%
	Reducing the Unnecessary Infrastructure Cost	3%	
	Transforming Abandoned Urban Brownfield Site	3%	
	TOTAL	100%	100%

C. Case Study Thematical Analysis, Stream Daylighting Challenges

Main Theme	Sub-Themes	Sub-Theme Percantage
Environmental and Ecological Challenges	Environmental Complications During the Construction	13.2%
	Urban Density and Infrastructure Constraints	18.9%
Project Planning and Management Challenges	Stakeholder Engagement and Collaboration	34.0%
	Urban Project Management	17.0%
	Economic Interest Management	17.0%

D. Case Study Thematical Analysis, Stream Daylighting Actions

MAIN THEME	SUB THEMES	Sub-Theme Percantage
Stakeholder Involvement	Active Engagement of Public	12.90%
	Educating Public about Project	11.40%
	Collaboration of Different Authorities	9.80%
Infrastructure Development	Accessibility and Connectivity Enhancements	9.10%
	Water Management Systems	6.10%
	Recreational and Aesthetic Improvements	5.30%
	Structural and Engineering Works	3.80%
	Safety and Nighttime Appeal	1.50%
Project Planning and Management	Development of Integrated Urban Plans	9.10%
	Establishing Project Monitoring and Assessment	8.30%
	Land Management	3.00%

Environmental Restoration	Stream Restoration and Modification	6.80%
	Enhancing Landscape Elements	6.10%
Policies and Legislative Regulations	Legal and Governmental Support	6.80%

E. Research Findings, Perception of Stream Daylighting Challenges

THEME	SUB-THEMES	Percentage of Sub-Themes Mentions (%)	Percentage of Total Mentions (%)
Project Management and Implementation Issues	Risks of Social Management of the Project	10.00%	27.20%
	Planning and Programming	6.80%	
	Risks Related to the Physical Design of the Project	6.50%	
	Post-Project Monitoring	3.90%	
Financial Problems	Limited Financial Resources	12.50%	19.70%
	Decision-Makers' Investment Approach and Persuasion Processes	5.70%	
	Project Costs and Unpredictability	1.40%	
Feasibility and Implementation Risks	Construction Phase Issues	5.40%	16.10%
	Technical and Infrastructure Problems and Risks	5.00%	
	The Risk Inadequate Feasibility Analyses	3.20%	
	The Risk of Public Health Issues	2.50%	
Institutional Capacity and Coordination	Lack of Scientific, Technical, and Project Management Capacity in Institutions	7.20%	13.60%
	Problems in Governance and Decision-Making Processes of Institutions	6.50%	
Social Political Concerns	Social Resistance and Concept of Ownership	6.80%	10.40%
	Political Instability	3.60%	

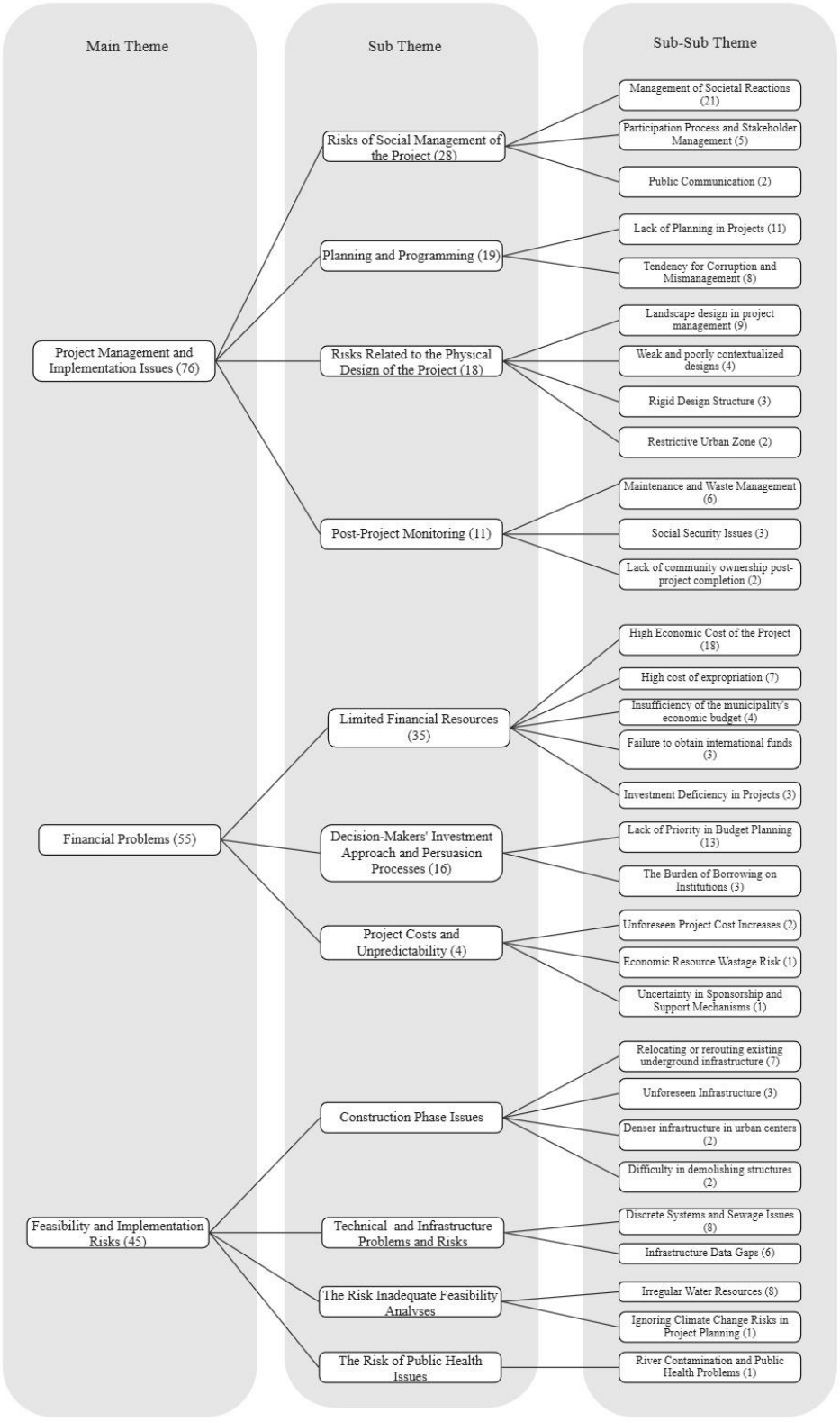
Problems Related to Participation Processes	Stakeholder Engagement and Communication	5.00%	6.80%
	Social Participation and Awareness	1.80%	
Legal Problems	Implementation of Regulations	3.60%	6.10%
	Gaps in Legal Regulations	2.50%	

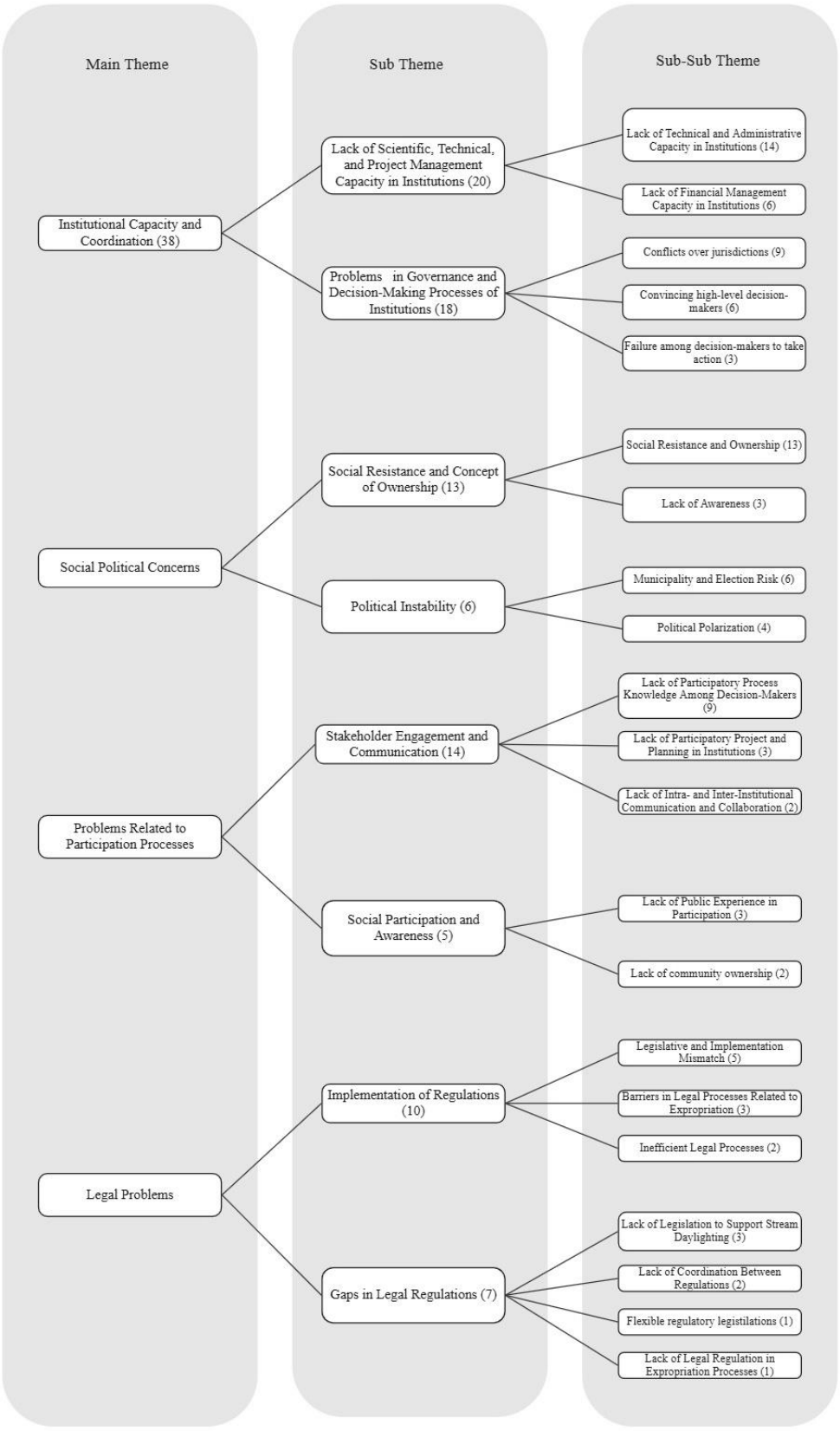
F. Research Findings, Perception of Stream Daylighting Actions

THEME	SUB-THEMES	Percentage of Sub-Themes Mentions (%)	Percentage of Total Mentions (%)
Project Management and Planning	Cross-Scale Planning and Phasing	19.00%	38.80%
	Communication and Dissemination	11.60%	
	Conducting Feasibility Studies	8.30%	
Project Site Selection and Design	Sustainable Urban and Landscape Design	10.70%	15.70%
	Land Acquisition	5.00%	
Public Participation and Public Awareness	Enabling Public Participation	9.10%	14.90%
	Raising Public Awareness	5.80%	
Technical and Infrastructural Development	Rainwater and Sewage Management	6.60%	8.30%
	Data Collection and Empowerment	1.70%	
Financial Management	Conducting Cost Benefit Analysis	5.00%	8.30%
	Securing Diverse Financial Resources	3.30%	

Institutional Capacity and Governance	Increasing the Transparency and Accountability of Institutions	2.50%	7.40%
	Improving the Participatory Processes of Institutions	2.50%	
	Strengthening Institutional Capacity	2.50%	
Legal Strategies	Protecting and Preserving Streams	3.30%	6.60%
	Strategic Decisions in Planning Processes	3.30%	

G. Perception of Stream Daylighting Challenges Content Analysis Tree




Main Theme
Sub Theme
Sub-Sub Theme
Institutional Capacity and Coordination (38)
Lack of Scientific, Technical, and Project Management Capacity in Institutions (20)
Lack of Technical and Administrative Capacity in Institutions (14)
Lack of Financial Management Capacity in Institutions (6)
Problems in Governance and Decision-Making Processes of Institutions (18)
Conflicts over jurisdictions (9)
Convincing high-level decision-makers (6)
Failure among decision-makers to take action (3)
Social Political Concerns
Social Resistance and Concept of Ownership (13)
Social Resistance and Ownership (13)
Lack of Awareness (3)
Political Instability (6)
Municipality and Election Risk (6)
Political Polarization (4)
Problems Related to Participation Processes
Stakeholder Engagement and Communication (14)
Lack of Participatory Process Knowledge Among Decision-Makers (9)
Lack of Participatory Project and Planning in Institutions (3)
Lack of Intra- and Inter-Institutional Communication and Collaboration (2)
Social Participation and Awareness (5)
Lack of Public Experience in Participation (3)
Lack of community ownership (2)
Legal Problems
Implementation of Regulations (10)
Legislative and Implementation Mismatch (5)
Barriers in Legal Processes Related to Expropriation (3)
Inefficient Legal Processes (2)
Gaps in Legal Regulations (7)
Lack of Legislation to Support Stream Daylighting (3)
Lack of Coordination Between Regulations (2)
Flexible regulatory legistilations (1)
Lack of Legal Regulation in Expropriation Processes (1)