UNIVERSITY OF LATVIA

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**Baiba Prūse**

# CO-CREATION OF KNOWLEDGE: SUPPORTING THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS THROUGH CITIZEN SCIENCE AND ETHNOBOTANY

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**FACULTY OF GEOGRAPHY AND EARTH SCIENCES**
**DEPARTMENT OF ENVIRONMENTAL SCIENCE**

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DOCTORAL THESIS
COLLECTION OF THEMATICALLY UNITED ARTICLES

Submitted for the degree of Doctor of Science (Ph.D.)
in Earth Sciences, Physical Geography and
Environmental Sciences

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The thesis contains an introduction, four chapters, reference list, acknowledgement and seven appendices.

Form of the thesis: a collection of thematically united articles in Earth Sciences, Physical Geography and Environmental Sciences.

Supervisor: **Dr. Māris Kļaviņš**, Professor, University of Latvia, Riga, Latvia

Consultant: **Dr. Renata Sõukand**, Associate Professor, Università Ca' Foscari Venezia, Italy

Reviewers:
**Dr. Jaime Piera Fernández**, Institute of Marine Sciences (ICM-CSIC), Spain
**Dr. Hans Peter Hansen**, Aarhus University, Denmark
**Dr. Raimonds Ernšteins**, University of Latvia, Latvia

Doctoral committee:
Prof. Dr. biol. **Viesturs Melecis**, chairman of the Committee
Prof. Dr. habil. chem. **Māris Kļaviņš**
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Doc., Dr. geogr. **Juris Burlakovs**
Assoc. Prof. Dr. geogr. **Iveta Šteinberga**

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**“Life is now or never”**

/ Alastair Humphreys /

# ANNOTATION

Policy documents of national and global importance stress the need to enhance cooperation between numerous actors on various levels to reach a better solution for the problem in hand. Knowledge *co-creation* with the public members are a crucial element in this matter. On this note, diversity of tools exists for integrating people in the decision-making process. For this study, citizen science and ethnobotany are explored regarding the knowledge co-creation process as part of supporting the implementation of Sustainable Development Goals (SDGs).

The research findings are combined from the author's ethnobotanical and citizen science studies. The combination of literature review and the results of the author's studies explains the difference between citizen science and ethnobotany, where one involves public members to provide a snap-shot of the situation, whereas the latter is a knowledge transformed throughout the generations.

Based on the study results, the author advocates for knowledge co-creation with and for the public through the means of citizen science and ethnobotany and lists specific SDGs and targets where both approaches may be directly applied with the focus on Latvia.

**Keywords:** ethnobotany, citizen science, co-creation, sustainable development

## LIST OF ABBREVIATIONS AND TERMS

CBD – The Convention on Biological Diversity

ECSA – European Citizen Science Association

FAO – The Food and Agriculture Organization of the United Nations

LEK – Local Ecological Knowledge

OECD – Organisation for Economic Co-operation and Development

SDG – Sustainable Development Goals

SDG 2 – End hunger, achieve food security and improved nutrition and promote sustainable agriculture

SDG 4 – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

SDG 14 – Conserve and sustainably use the oceans, seas and marine resources for sustainable development

SDG 15 – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

UN – The United Nations

UNEP – The United Nations Environment Programme

UNESCO – The United Nations Educational, Scientific and Cultural Organization

Ibid. – In the same place

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# INTRODUCTION

Scholars (Norström et al., 2020), practitioners (Fritz et al., 2019; Wehn et al., 2020) and policy briefs from Aichi Biodiversity targets (CBD, 2018), UNESCO (Scientific Advisory Board, 2016) and United Nations Sustainable Development Goals (SDGs) (UN General Assembly, 2015) emphasise the high importance and benefit of integrating peoples knowledge while discussing sustainability and natural resource management. The previous note and the work of historical figures as Carl Linnaeus (Stearn, 1994) and numerous scholars and practitioners within the subject of public engagement such as Elinor Ostrom (Ostrom & Whitaker, 1973), Rick Bonney (Bonney, Phillips, Ballard, & Enck, 2015) and Ulysses Paulino de Albuquerque (Albuquerque, da Cunha, de Lucena, & Alves, 2019), to name some, serves as a source for inspiration to focus the thesis in the direction of *co-creating* knowledge through citizen science and ethnobotany, particularly in link to SDGs.

In a nutshell, citizen science and ethnobotany rely on the cooperation between lay-people and researchers (see Chapter 1). Citizen science activities particularly the ones defined as co-created[1] (here after co-created$^{cs}$) are highly-priced among scholars and holds a positive impact to resource management as well as in framing policies (Bonney et al., 2015; Paper I, II). Ethnobotany in this respect, re-constructs and *co-creates* knowledge with and for local communities (Hopkins et al., 2019; Paper III, IV, V).

Before going any further time must be spent on two terms used for the work: knowledge and *co-creation*. The concept of knowledge is very ambitious and reaches back to philosophers of Plato and Aristotle, and the author does not intend to discuss the subject from epistemological perspectives (see: Bolisani & Bratianu, 2018; Greco & Sosa, 1999). However, it must be stressed that epistemology asks provoking questions of "what knowledge is" and "how knowledge is gained" (Rescher, 2003) which in turn is relevant in understanding the difference between citizen science and ethnobotany in terms of knowledge production. Based on the various concepts of knowledge, the author applies the following division:

- citizen science (excluding co-created$^{cs}$ activities for the time being) is primarily based on facts or so named propositional knowledge (see: Rescher, 2003) through personal observations. To add, citizen science is more fixed content-driven in comparison to ethnobotany. Here we may also employ the terminology of – explicit knowledge = *knowing – that* (Nonaka & Takeuchi, 1995) with the characteristics of being objective, rational, technical (Virkus, 2014).
- ethnobotany, on the other hand, is about the way of knowing or so-called – *know-how* knowledge (see: Rescher, 2003). As to this, the author stresses that the knowledge documented through ethnobotany may adopt the description identified by Berkes and Fikret (2008, p. 4): "knowledge as process – as opposed

[1] Co-created citizen science initiatives "are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all aspects of the research process" (Shirk et al., 2012).

to knowledge as content." Here we may also apply the terminology of tacit knowledge = *knowing how*, (Nonaka & Takeuchi, 1995) characterised by subjective, cognitive, experiential learning (Virkus, 2014).

*Co-creation* with various actors is a process related to a diversity of concepts, including public participation, collaborative governance and community involvement (Voorberg, Bekkers, & Tummers, 2015), to name some. The author chooses to employ the definition as used by the work of Voorberg et al. (2015, p. 3): "co-creation refers to the active involvement of end-users in various stages of the production process (Prahalad and Ramaswamy 2000; Vargo and Lusch 2004)." The author of the thesis proposes that citizen science and ethnobotany falls under the chosen definition as both approaches involve public members in the process (Chapter I). Depending on the form of citizen science, the product in interest or output includes data production through observations provided by participants supporting the initiatives of researchers, to name some example (ibid.). For ethnobotany the processes are mainly initiated by researchers and is related to the collection or documentation of plant uses provided by the community members (ibid.). Here the main output are the interviewee records of plant uses (ibid.). In terms of time, citizen science gathered data most of the times is rather a snap-shot of the moment in interest whereas for ethnobotany – the data gathered has developed throughout the time of many generations (ibid.).

## Scientific novelty and relevance

The Food and Agriculture Organization of the United Nations (FAO) (2009) notes that the use of traditional practices can re-establish local food systems while increasing socio-environmental sustainability and resilience. Aichi Biodiversity targets, particularly number 18 indicates the need to respect indigenous and local communities' traditional knowledge and practices and integrate into the implementation of the Convention of Biological Diversity (CBD, 2018; Coates, 2018). Sustainable Development Goals, namely Goal 16 'Promote peaceful and inclusive societies for sustainable development,' adds a Target, which stresses the participatory process in decision making at all levels (UN General Assembly, 2015). Additionally, scholars note the value of public participation in achieving SDGs (Fox et al., 2017; Fraisl et al., 2020) both in Western and Asian societies (ExCiteS, 2019).

'Sustainable Development Strategy of Latvia until 2030' notes co-operation among various levels (including vertical dimension) as one of the strategic principles (Saeima of the Republic of Latvia, 2010). Unfortunately, recent OECD (2019) reports stress that Latvia exhibits limited progress for reaching Aichi Biodiversity targets concerning the integration of traditional knowledge. In this respect, the author emphasizes the importance of ethnobotany for understanding the local knowledge on natural resources, including but not limited to various uses of plants (e.g., Prance, 2007; Quave & Pieroni, 2015).

Acknowledging the importance of the diversity of public engagement in achieving various policy targets, the author of the thesis chooses to focus on citizen science (Paper I, II) and ethnobotany (Paper III–VII) as one of the tools in *co-creating* knowledge for reaching SDGs. To the best authors knowledge, limited peer-reviewed studies exist regarding wild plant uses in Latvia (see recent studies: analysis from Archives of Latvian Folklore by Sile et al. (2020); Ph.D. dissertation on folk healing by Ančevska (2018)). Besides the research in the previously understudied region from the ethnobotanical perspective, the study contributes to the discussion of the importance of lay people's voices. Paper V adds on the relevance in adding emic perspective during the environmental decision-making process.

## Research aim and tasks

The study aims to explore citizen science and ethnobotany as a tool for *co-creating* knowledge to support the implementation of SDGs. To reach the set aim, the following research tasks are introduced indicating the number of Papers and thesis chapters which tackles these aspects:

1. **To understand how does citizen science and ethnobotany address *co-creation* of knowledge.**
   Paper: Paper I–VII, Chapter I
2. **To understand how does *co-creation* of knowledge through citizen science and ethnobotany support SDGs.**
   Paper: I, III–V, Chapter I and III
3. **To understand what is the potential and under what conditions for citizen science and ethnobotany initiatives to be enhanced in Latvia.**
   Paper: II–V, Chapter IV

## Hypothesis

Citizen science and ethnobotany can serve as a tool in *co-creating* knowledge in respect of supporting the implementation of SDGs.

## Thesis structure

The thesis is based on seven peer-reviewed articles (Appendix I–VII) with introduction and four additional chapters. Introduction – introduced reader with the subject and provides a background on the main subjects used for the thesis. Chapter 1 (Literature review) – carries the reader through the subject. Chapter 2 (Material and methods) – provides a detailed description on the methodology used. Chapter 3 (Results and discussion) – outlines the key findings for each Paper with additional discussion on co-creation process and SDGs. Chapter 4 (Conclusions) – describes the main conclusions and provides the recommendations in Latvian context. The summary of the thesis is also translated in Latvian language. The scientific articles are included in the printed version as an additional material (Appendix I–VII).

The following is presenting peer-reviewed publications included in the Ph.D. thesis:

(I) Tauginiene, L., Butkevičiene, E., Vohland, K., Heinisch, B., Daskolia, M., Suškevičs, M., Portela, M., Balazs, B., **Prūse, B**. (2020). Citizen Science in the Social Sciences and Humanities – the Power of Interdisciplinarity. *Palgrave*

*Communications* 6, 89, 1–11. doi:10.1057/s41599-020-0471-y; SCOPUS; Web of Science.

(II) Skarlatidou, A., Suškevičs, M., Göbel, C., **Prūse, B.**, Tauginienė, L., Mascarenhas, A., Mazzonetto, M., Sheppard, A., Barrett, J., Haklay, M., Baruch, A., Moraitopoulou, E.-A., Austen, K., Baïz, I., Berditchevskaia, A., Berényi, E., Hoyte, S., Kleijssen, L., Kragh, G., Legris, M., Mansilla-Sanchez, A., Nold, C., Vitos, M. and Wyszomirski, P. (2019). The Value of Stakeholder Mapping to Enhance Co-Creation in Citizen Science Initiatives. *Citizen Science: Theory and Practice*, 4(1): 24, 1–10. doi:10.5334/cstp.226, DOAJ.

(III) **Prūse, B**., Simanova, A., Mežaka, I., Kalle, R., Prakofjewa, J., Pieroni, A., Holsta, I., Krūzkopa, K., Sõukand, R. Active wild food practices in the 21st century across Latgale, Latvia. *Environment, Development and Sustainability*. – revision phase, IF=1,676; SCOPUS; Web of Science.

(IV) Simanova, A., **Prūse, B*.**, Kalle, R., Kochalski, S., Prakofjewa, J., Mežaka, I., Pieroni, A., Soukand, R. Medicinal plant use at the beginning of 21st century among the religious minority in Latgale Region, Latvia. *Ethnobotany Research and Applications,* 1–31. doi: 10.32859/era.20.21.1-31 (*corresponding author), SCOPUS.

(V) **Prūse**, **B*.**, Kalle, R., Buffa, G., Simanova, A., Mežaka, I., Sõukand, R. We need to appreciate the common synanthropic plants before they become rare: Case study in Latgale (Latvia). *Ethnobiology and Conservation*. – revision phase (*corresponding author), SJR 0.6, Q1; SCOPUS; Web of Science.

(VI) Soukand, R., Mattalia, G., Kolosova, V., Stryamets, N., Prakofjewa, J., Belichenko, O., Kuznetsova, N., Minuzzi, S., Keedus, L., **Pruse, B.**, Simanova, A., Oppolitova, A., Kalle, R. (2019) Inventing a herbal tradition: The complex roots of the current popularity of *Epilobium angustifolium* in Eastern Europe. *Journal of Ethnopharmacology* 247, 1–14. doi: 10.1016/j.jep.2019.112254; IF=3,414; SCOPUS; Web of Science.

(VII) Kalle, R., Belichenko, O., Kuznetsova, N., Kolosova, V., Prakofjewa, J., Stryamets, N., Mattalia, G., Šarka, P., Simanova, A., **Prūse, B.**, Mezaka, I., Sõukand, R. (2020). Gaining momentum: Popularization of *Epilobium angustifolium* as food and recreational tea on the Eastern edge of Europe. *Appetite* 150, 104638. doi: 10.1016/j.appet.2020.104638; IF=3,501; SCOPUS, Web of Science.

Each study complements a deeper understanding of how citizen science and ethnobotany *co-creates* knowledge and whose voices to be heard. Figure 1 represents the core themes covered in each study in order to answers the set research aim.

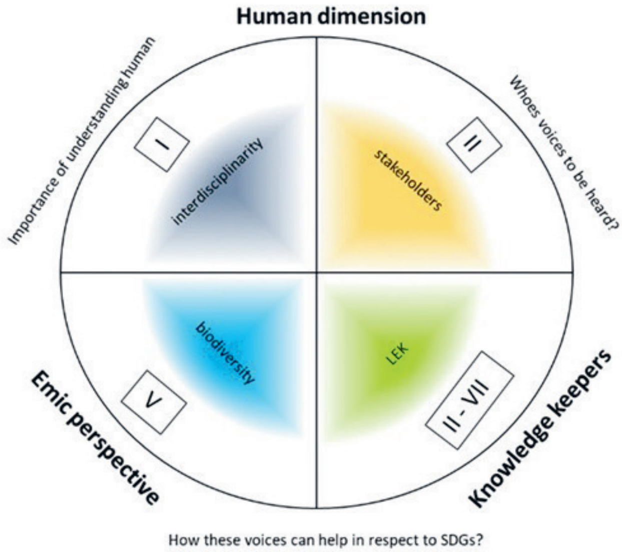



**Figure 1.** Main themes and concepts integrated into the thesis. I–VII: number of authors study.

Due to the complexity of the study subject, several methods were applied, including ethnobotanical fieldwork in Latgale region, meta-synthesis, stakeholder mapping (Chapter II).

### Author's contribution and limitations of the work

Regarding **Paper I** author analysed the selected papers in natural sciences and wrote a section for the manuscript and edited parts of the manuscript after the reviewers' comments. Authors work for **Paper II** consist of contribution in study design, data analysis, contributing to the case studies for the manuscript and edited parts of the manuscript after the reviewers' comments. Regarding **Paper III and IV** author designed the study, drafted the manuscript, conducted the fieldwork. For **Paper V** – conceived of the presented idea, carried out the experiment, carried out the data analysis, wrote the first and final draft of the manuscript. Regarding **Paper VI and VII** author conducted the fieldwork.

The thesis was conducted under the supervision of Prof. Māris Kļaviņš and consultation of Prof. Renata Sõukand. **Paper I–II** was performed in close cooperation with the first authors. **Paper III–V** performed under the close supervision of Prof. Sõukand with the consultation of Prof. Andrea Pieroni and Dr Raivo Kalle. **Paper VI–VII** was performed under the supervision of the first and last author.

To obtain the studies, the author has undergone training in ethnobotany, which took place in Italy and Latvia. Besides that, collaborative work with laypeople has been practised by citizen science pilot activity at Lake Burtnieks. To add, the author has visited citizen science practitioners in Finland and the United Kingdom, including Science Shop's coordinators in Germany and France, and learned from their experiences.

The study seeks to understand certain aspects of citizen science and ethnobotany in link to SDGs; however, it does not intend to provide throughout the review. To add, the methods employed are diverse in character; however, the thesis does not look at the possible drawbacks for each of the methods used. This, on the other hand, are parts to be looked at in future studies.

## Related studies not included in the Ph.D. thesis

1. Contribution to the book chapter – Frigerio, D., Richter, A., Per, E., **Pruse, B.**, Vohland, K. (in press). Chapter 5 Citizen Science in the Natural Sciences. In K. Vohland et al. (eds.), *The Science of Citizen Science*. Springer International Publishing.
2. Manzoni, M.; Vohland, K.; Göbel, C.; **Pruse, B.**; Schade, S. (2019). Citizen Science Strategies in Europe – preliminary findings from the pan-European Survey of Citizen Science Strategies and initiatives in Europe as part of a joint initiative of the COST ACTION 15212 and the JRC discussed in Cēsis, Latvia, 4th June 2019. doi: 10.7479/myw2-9584
3. **Prūse, B.**, Dātava, G. (2017). Citizen Science in Latvia within the field of environment. Institute for Environmental Solutions, Priekuļi, Latvia
4. Dimante, Dž.; Žagars, M.; **Prūse, B.** (2016). Report of socio-economic value of Lake Alūksne. Institute for Environmental Solutions, Priekuļi, Latvia (in Latvian)

## Selected international and national conferences and seminars

1. **Prūse, B.***, Simanova, A.*, Kalle, R., Mežaka, I., Brauns, A., Jakovels, D., Filipovs, J., Holsta, I., Krūzkopa, S., Soukand, R., 2018. *Habitat alteration as one of the drivers of the change in wild plant uses*. Poster presentation at the First Baltic Conference on the Environmental Humanities and Social Sciences (BALTEHUMS), Riga, Latvia. (*corresponding authors)
2. **Prūse, B.**; Dieviņa, M.; Buholce, L.; Žagars, M. (2017). *A research expedition in Trang Province, Thailand by University of Latvia students* (in Latvian). Oral presentation at the 75th Conference of the University of Latvia, Riga, Latvia.
3. Dieviņa, M.; Žagars, M.; Dātava; G.; **Prūse, B.** (2016). *Communicating the climate crisis on a local scale.* Poster session presented at the conference – Climate Existence, Sigtuna, Sweden.
4. Participation at Latvian Ministry of Education and Science seminar on Citizen Science (28.08.2020.).

## Planned / postponed due to CoVid-19 outbreak

5. **Prūse, B.**, Puncule, L., Kochalski, S., Balode, L., Žagars, M. *The potential of CITIZEN SCIENCE in lake research: a case study of Lake Burtnieks*. Oral presentation at Biological and Cultural Diversity in the Context of European Vulnerable Ecosystems, Venice, Italy.

6. Kronberga, A., Mežaka, I., Nakurte, I., **Prūse, B.**, Pugovičs, O., Dambrova, M., Grīnberga, S., Sīle, I. *Inovatīvi risinājumi pavasara savvaļas ārstniecības un aromātisko augu audzēšanas tehnoloģijās un izmantošanā* [Innovative solutions for growing technologies and applications of wild spring medicinal and aromatic plants]. Poster presentation at the 78th Conference of the University of Latvia, Riga, Latvia.
7. Simanova, A., Kalle, R., **Prūse, B**., Prakofjewa, J., Mežaka, I., Holsta, I., Krūzkopa, S., Sõukand, R. *Ritual Trees Among Baltic Countries – in Landscape, Festivals and Human Life*. Oral presentation for the conference BALTEHUMS II, Kaunas, Lithuania.
8. Tauginiene^, L., Butkevičiene^, E., Vohland, K., Heinisch^, B., Daskolia, M., Suškevičs, M., Portela, M., Balazs, B., **Prūse^, B**. *Exploring Synergies between Citizen Science and Social Sciences and Humanities.* Oral presentation as part of the online conference ECSA2020. (^presenters)
9. **Chairperson** for the session: *Citizen science case study: cross-cultural settings* (08.09.2020.) at online conference ECSA2020 (06.–11.09.2020.).

# 1. CHAPTER

## 1.1. LITERATURE REVIEW

The literature review aims to introduce the reader with citizen science and ethnobotany as tools for *co-creating* knowledge with respect to SDGs. By the following, the author of the thesis does not intend to provide throughout review but shortly introduce the reader with the central concept of citizen science, concentrating mainly on the field of environmental sciences. Additionally, the author will lay out the general principles of ethnobotany. Each concept is supported by a short reflection on selected case studies based on case study relevance and applicability to other geographical locations.

The chapter will begin with the general concept of *co-creating* knowledge driven by the examples from natural resource management. The final section of the chapter will provide the link between sustainable development and *co-creation* of knowledge.

### 1.1.1. Co-creating knowledge for the sustainable natural resource management process

Adaptive management (Fabricius & Cundill, 2014; Rist, Felton, Samuelsson, Sandström, & Rosvall, 2013), environmental governance (Mistry & Berardi, 2016), adaptive governance (Ostrom, 2008) and participatory research (Johnson, Lilja, Ashby, & Garcia, 2004) are some of the umbrella concepts in natural resource management domain where public participation serve a central part in knowledge production. Some scholars note the term – "knowledge exchange" while discussing environmental governance (Fazey et al., 2013; Reed, Stringer, Fazey, Evely, & Kruijsen, 2014). Numerous scholars note the importance of integrating local community knowledge in sustainable natural resource management (Berkes, Colding & Folke, 2000; Brondizio & Le Tourneau, 2016; Lockwood, Davidson, Curtis, Stratford, & Griffith, 2010). Mistry and Berardi (2016, p. 1274) emphasize "that any effort to solve real-world problems should first engage with those local communities that are most affected, beginning from the perspective of indigenous knowledge and then seeking relevant scientific knowledge – not to validate indigenous knowledge, but to expand the range of options for action." As summarized by Lockwood et al. (2010) various sources of knowledge need to be respected in regard to sustainable natural resource management by including science-based knowledge as well as local experience and knowledge from indigenous communities. As nicely captured "traditional knowledge, as a way of knowing, is similar to Western science in that it is based on an accumulation of observations, but it is different from science in some fundamental ways" (Berkes et al., 2000, p. 1251). Berkes et al. (2000) reflects on the views provided by anthropologist C. Levi-Strauss which specify that the difference is hidden by the way of learning about the world.

### 1.1.2. Citizen science approach

A growing number of people worldwide are participating in citizen science initiatives through various forms, including collection and analysis of data (European Commission, 2017a, 2020; Paper I, II). The number of people involved in these activities to some cases reaches close to a hundred thousand (e.g., Cohn, 2008) and possibly even more. Scholars note that the recent increase of the citizen science activities is due to the available technologies including virtual environmental observations (Karpouzoglou et al., 2016), artificial intelligence (Ceccaroni et al., 2019), low-cost tools and diversity of measures (Liu & Kobernus, 2017; UNEP, 2014; Roy et al., 2012). Additionally, the European Commission emphasises the need to include citizen science activities whenever possible in order to maximise research and innovation goals across the European Union (European Commission, 2017b). The topics covered through citizen science initiatives are diverse in time and space and across various themes reaching from health and wildlife monitoring, educational activities to Artic studies (Eitzel et al., 2017; Kullenberg & Kasperowski, 2016; Roy et al., 2012; Picture 1). One of the most representable examples of the high diversity of projects can be seen through the international citizen science platforms such as SciStarter, PlutoF, EU-Citizen.Science, to name some.


**Picture 1.** Involving anglers in contributing with samples from the caught fish – initiative organized by the author of the thesis at Lake Burtnieks. Credit: BP

Citizen science as a research field (Jordan, Crall, Gray, Phillips, & Mellor, 2015) yet lacks one single definition. According to the United Nations Environment Programme citizen science is defined by public participation in research (UNEP, 2014). To add, the participants of the activities in interest are defined as 'citizen scientists' (Louv & Fitzpatrick, 2012). However, some studies also tend to use the term volunteers as synonyms to citizen scientists (e.g., Crall et al., 2010). European Citizen Science Association holding the most unified opinion (Science Europe, 2018) defines citizen science through ten principles including the following: "citizen science provides opportunity for greater public engagement and democratisation of science (…) and actively involve citizens in scientific endeavour that generates new knowledge or understanding" (ECSA, 2015). Recent studies introduce several criteria as well as aspects of what is and what is not citizen science (see: ECSA, 2020; Heigl, Kieslinger, Paul, Uhlik, & Dörler, 2019). Hecker et al. (2018a) add crowdsourcing, public engagement of science, public understanding of science, community science under the term citizen science. On top of that, Shirk et al. (2012) propose Public Participation in Scientific Research as the overreaching category, which includes initiatives linked with citizen science. Eitzel et al. (2017) share various strategies on choosing the terminology, adding the need to clearly define what is meant by citizen science for the project in interest. Additionally, in some instances, citizen science is approached as a method for public involvement in scientific data gathering (Cooper, Dickinson, Phillips, & Bonney, 2007).

Although the term has been introduced in the '90s (Eitzel et al., 2017), the use of citizen science approach reaches back to Linnaeus times (Liu & Kobernus, 2017) and even earlier. Some scholars even note Aristotle times by emphasizing the historical background of citizen science (Dickinson et al., 2012). As an example, the documentation of the flowering of cherry trees in Japan dates back more than a thousand years ago (UNEP, 2014). Some even claim that citizen science has been around since the beginning of scientific activities (Liu & Kobernus, 2017). However, precaution needs to be taken towards the link of historical "citizen science" activities. As summarized by Strasser et al. (2019, p. 58) the historical link to citizen science "is interesting as an attempt at "inventing a tradition" (Hobsbawm and Ranger, 1983) that could legitimize today's participatory research."

In Latvia, the term citizen science was actively used through the work of the Institute for Environmental Solutions while translating the ten principles of citizen science noted by ECSA (IES, 2016). Nevertheless, public institutions such as Nature Conservation Agency and non-governmental organisations such as Latvian Fund for Nature use a similar term integrating the concept as provided by ECSA (2015).

Various forms exist while discussing citizen science initiatives. In academia most widely spread classifications on citizen science are introduced by Haklay (2013), Shirk et al. (2012), Roy et al. (2012) and Wiggins and Crowston (2011). A typology of citizen science provided by Wiggins and Crowston (2011) considers the physical environment and the goal of the project. Action, conservation, investigation, virtual and educational oriented are the four categories provided by the scholars (Wiggins & Crowston, 2011). As for example, conservation projects hold a regional base and linked with natural resource management questions. Whereas, projects organized through information and communication technologies with no physical aspects are defined under the virtual category (ibid.). Shirk et al. (2012) introduce additional categories based on the degree of participation: contractual, contributory, collaborative, co-created, collegial. Roy et al. (2012) employ additional division based on mass participation and the thoroughness of the project. Haklay (2013), on the other hand, provides four levels of participation in citizen science activities followed by the participants level of integration in the research process. The first and primary level as defined by Haklay (2013) is term as 'crowdsourcing' with minimal participant engagement in the process. The final and most complexed level is 'extreme citizen science' defined as collaborative work (Haklay, 2013).

Recent studies note that the main form of citizen science across Europe are linked with data collection (Hecker et al., 2018b) employing mainly crowdsourcing form (Heinisch, 2017). However, each of the different forms of citizen science activities requires different input and activities for designing the initiatives. Scholars note that "although cocreated projects are driven and organized to a large degree by communities, they may actually involve as much if not more input, resources, and commitment by scientists than would a contributory project" (Shirk et al., 2012). The author of the thesis work notes that most of citizen science activities in Latvia can be categorized as contributory projects, e.g., Dabasdati.lv platform and mainly characterised as educational, e.g., Bērnu Vides skola Globe Programme and investigation projects, e.g., monitoring activities organized by Nature Conservation Agency.

Citizen science projects hold numerous benefits for science and society in large. Scholars particularly emphasize the benefit of co-created[cs] and collaborative projects (Dickinson et al., 2012; Roy et al., 2012; see Paper II) and highlight the need to increase this type of citizen science (Brauer, 2018). Ferran-Ferrer (2015) stress the importance of knowledge creation by and for people in order to reach the turn of scientific questions also coming from the outside academic arena. Scholars note the potential of citizen science in respect to monitoring progress of SDGs (Fritz et al., 2019) as well as supporting sustainability transitions (Sauermann et al., 2020). However, Mirowski (2017, 2018) questions – "whose interests it's really serving." Vohland et al. (2019) discuss conflicting issues in citizen science related to commercial use of the gathered data. "Citizen science is ambivalent: It can either strengthen or challenge neo-liberalization of science" (Vohland et al., 2019).

Various countries gain valuable data gathered by citizen scientists. United Kingdom reports a high dependency on volunteer contribution in biodiversity monitoring (Mackechnie, Maskell, & Roy, 2011). Also, in Latvia, volunteer gathered data for specific bird taxa contribute to Latvian National Biological Diversity Programme 2015–2020 (VARAM, 2015). However, scholars note numerous benefits driven by citizen science activities beyond collected data (West & Pateman, 2017). Some of these outcomes include the integration of people in the decision-making process (Bonney et al., 2015) and bringing them closer to policy processes (Hecker et al., 2018a; Kasperowski & Brounéus, 2016), empowering communities (Petridis, Fischer-Kowalski, Singh, & Noll, 2017) and co-creating new ideas and innovations (Hecker et al., 2018a), increase awareness of scientific research as well as contribute in education processes (Bonney et al., 2015; Kasperowski & Brounéus, 2016; Miczajka, Klein, & Pufal, 2015; Wals, Brody, Dillon, & Stevenson, 2014; see Paper I). Shirk et al. (2012) address outcomes and outputs of citizen science projects. Outcomes are measured by skills, knowledge, whereas outputs are the results of the project, such as data (ibid.). Under the nature conservation domain, three levels of outcomes are defined based on individual, research and socio-ecological system (ibid.). On the individual participant level the outcomes from citizen science projects include a set of new skills, expertise and understanding of the research process as well as enhance the human-nature relationship (ibid). On the research level, the outcomes vary from increase understanding of the natural world, including but not limited to climate change, distribution of species and much more (ibid.). Dickinson et al. (2010) note the applicability of citizen science projects in studying biodiversity loss and habitat change; especially while considering the change over extensive geographical coverage and through a long period of time (Dickinson et al., 2012; Louv & Fitzpatrick, 2012). Other scholars hold a different approach of looking at citizen science outcomes in comparison of Shirk et al. (2012). Community-scale, programmatic, scientific literacy and environmental awareness are noted as outcomes by Dickinson et al. (2010). As for the socio-ecological system, the outcomes include improved collaboration between communities and decision-makers (ibid.). Scholars also differentiate long term and short term impact driven by citizen science initiatives, however rarely and challenging to measure (Shirk et al., 2012).

Scholars particularly recognize and acknowledge, the contribution of citizen participation towards environmental issues (Dickinson et al., 2012; Louv & Fitzpatrick, 2012) and its long history (Liu & Kobernus, 2017) as well its contribution to sustainable development (Liu, Kobernus, Broday, & Bartonova, 2014). While discussing conservation strategies in the human inhabited environment, citizen science approach has been named as a useful tool for reaching a positive and measurable impact on the biodiversity (Cooper et al., 2007). According to Crain et al. (2014) as for ecological research, citizen science has gained its momentum. As for the current moment, the driving discipline for citizen science across Europe is led by ecological and environmental disciplines (Hecker et al., 2018b). Additionally, increasing attention is noted in respect of including social data in citizen science projects (Crain et al., 2014; see Paper I). And yet, in natural science studies which employ citizen science rarely name the roles for citizen scientists and/or tasks and recruitment processes (see Paper I).

The motivation behind the citizen scientist is somewhat complex and diverse. Interest to develop a more profound knowledge of the environment, love to nature, curiosity and fulfilment of being part of research activities are only part of the driving force for citizen scientists to take part in the initiatives (Geoghegan, Dyke, Pateman, West, & Everett, 2016; Cohn, 2008). Geoghegan et al. (2016, p. 30) note that only a few studies approach citizen science motivations and provide an overview of the existing approaches identifying that "the importance of different motivations appears to vary between projects."

Although the citizen science approach is highly valued, there are also opportunities and challenges to overcome. The report on environmental citizen science notes the potential of involving citizens in monitoring species which up-to-now has received little attention such as insects (Science Communication Unit, 2013). Additionally, the funding stability, as well as data quality, are listed as part of critical challenges (ibid.).

In order to provide the diversity of the range of the thematical areas, the author of the thesis provides a closer look at four case studies (Box 1–3). The following studies are chosen from natural science discipline with close attention to the collaborative and co-created[cs] projects. Each of the study listed includes the information on the citizen science form, the time range, geographical coverage as well as providing a short overview of the project. The author has met and collaborated on various subjects with the organizers of the listed case studies.

**BOX 1**

**Case study 1: Besatzfisch**

**Citizen science form: collaborative research***
**Timescale: 2010–2013**
**Location: Germany**
**Project web page:** http://www.besatz-fisch.de/
*as noted in Hecker et al. (2018)

Eighteen angling clubs joined researchers in a transdisciplinary research project which focused on various fish stocking practices (Mazumdar et al., 2018). In close cooperation with anglers, researchers organized the experimental setting and through workshops developed specific objectives for the project (ibid.). Additionally, the outcomes of the various stocking treatments were jointly monitored with the involved stakeholders (ibid.). The scholars emphasised that angler involvement in the research process improved their ecological knowledge (ibid.).

**BOX 2**

**Case study 2: Swedish Mass experiment**

**Citizen science form: contributary/collaborative***
**Timescale: 2009–now**
**Location: Sweden**
**Project web page:**
https://forskarfredag.se/researchers-night/mass-experiments/
*Assigned by the author of the thesis

Since 2009 as part of the European Researchers' Night Vetenskap & Allmanhet organizes mass experiment through the involvement of pupils across Swedish schools (ForskarFredag, n.d.; Kasperowski & Brounéus, 2016). Together with the researchers each year, the organizers set a different theme. The topics covered in past events include – the development of autumn leaves, decomposition of organic matter in the soil (for more see: Kasperowski & Brounéus, 2016). The main tasks by the involved students are to document the phenomena in question through observations (ibid.). As highlighted by the researchers, the primary added value of this event is the educational aspect of brining pupils closer to the real-life research process (ibid).

**BOX 3**

**Case study 3: Jukajoki restoration project**

**Citizen science form: co-created***
**Timescale: 2010–now**
**Location: Finland**
**Project web page:** http://casestudies.ourplaceonearth.org/finland/
*Assigned by the author of the thesis

Jukajoki restoration project is a highly awarded initiative (Energy Globe Award, n.d.) and provides an exemplary case of collaborative management and active learning (Key, 2016). Local and traditional knowledge supports scientific data and defining it as a "parallel stream of information" and treated as an equal source of information (ibid.). As for example, local fisherman supports the restoration efforts by observing the change in fish spawning behaviour. The restoration project has developed a close partnership between scientists, villagers leading to positive ecological outcomes (ibid.).

From the case studies presented above the output or the knowledge varies from case to case. As for the Swedish experiment (contributory/collaborative citizen science approach), the knowledge *co-created* in cooperation between researchers and pupils includes short term observations, e.g., autumn leaves. On the other hand, folk knowledge on environmental change (long term) was represented in the case of Finland (co-created[cs] approach).

### 1.1.3. Ethnobotanical approach

Ethnobotany is a scientific discipline (Albuquerque, Ramos, Ferreira Júnior, & de Medeiros, 2017) with the core idea to investigate human-plant relationship by recording and preserving the local community knowledge (Pieroni & Privitera, 2014). A diversity of terms are used to express the studied subject, including traditional, local, folk, indigenous knowledge (Alves & Albuquerque, 2010). For simplicity, it could also be explained that the knowledge keepers are the local people; although for the sake of clarity, scholars urge to explain the meaning of the used terms. Schultes (2008, p. 811) nicely catch the essence of the knowledge captured by ethnobotanical studies pointing out that for many people the inherited knowledge of the surrounding: "Many peoples around the world are very knowledgeable about their ambient vegetation as a result of inherited knowledge, the result of hundreds of years of experimentation."

Similarly, as with citizen science, the history of ethnobotany reaches long before the term was officially introduced. As stressed by Svanberg et al. (2011, p. 191) "in every ancient culture with a written language, people have recorded useful knowledge about animals, plants, and environments." However, the term 'ethnobotany' was first named by American botanist John Hershberger introduced in 1895

(Albuquerque et al., 2017). Schultes (2008) notes that the definition by Hershberger "was used narrowly in reference to the use of plants by aboriginal people." While discussing the overreaching discipline of ethnobotany, various divisions appear. As for example, Martin (1995) notes that ethnoecology contain subdisciplines studying the interaction between local people and the environment such as ethnobotany, ethnobiology, ethnoentomology and ethnozoology. As summarized by Martin (1995, xx) ethnoecology is – "the study of how people interact with all aspects of the natural environment, including plants and animals, landforms, forest types and soils, among many other things." On contrary, Albuquerque et al. (2017, p. 1) adds ethnoecology and ethnobotany as part of a discipline of ethnobiology. In this respect, ethnobiology is a "discipline that includes the study of direct interrelations between humans and biota, among other things."

Nowadays, ethnobotanical research goes beyond documenting the local knowledge and employ a much more comprehensive approach including the study on the relationship between plants and people and the reason the possible differences (Albuquerque et al., 2017; Leonti, 2011; Nolan & Turner, 2011). Some scholars particularly stress the aspect of living cultures and their interrelationship with the plants while defining the discipline (Albuquerque et al., 2017). On top of that, scholars advise collaborating closely with the communities studied (Rodrigues et al., 2020; Vandebroek, Reyes-garcía, Albuquerque, Bussmann, & Pieroni, 2011). In Latvia, the term ethnobotany rarely circulates in academia with only a few peer-reviewed studies to the best authors knowledge, e.g., Sile et al. (2020).

As noted by scholars, many ethnobotanical studies explore the use of medicinal plants (Albuquerque et al., 2017, 2013) with discoveries of certain drugs (Pandey & Tripathi, 2017; Farnsworth, Akerele, Bingel, Soejarto, & Guo, 1985). Besides the documented practices, ethnobotanical researcher serves as a mediator between scientific and local community knowledge (Albuquerque et al., 2017). Present ethnobotanical investigations might benefit many other fields such as technology, sociology and modern science, including aspects related to nutrition and environmental conservation (Schultes, 2008). Albuquerque et al. (2017, p. 58) add the aspect of food security, noting that the discipline provides the opportunity to discover "important cultivars traditionally manipulated and unknown to our science." To add, ethnobotany has been recognized as an essential source to support biodiversity and nature conservation (Heneidy, Halmy, & Bidak, 2018; Pandey & Tripathi, 2017; Paper V) through the integration of traditional knowledge of the local communities in interest (Bussmann, 2002) as well as exploring the underlying cultural worldviews in respect to the peoples' actions towards the ecosystem in interest (Nolan & Turner, 2011). Vandebroek et al. (2011) also adds an educational aspect where local knowledge might serve its part in school curricula.

Scholars in the ethnobotanical discipline also study the various triggers including ecological, chemical and cultural factors which affect the folk plant uses and transmission of knowledge. Some of the cultural aspects include language (Menendez-Baceta et al., 2015), the formation of new borders (Sõukand & Pieroni, 2016), access to information (Akerreta, Cavero, López, & Calvo, 2007). Also, demographic aspects as gender (Nesheim, Dhillion, & Stølen, 2006) and age (Nolan & Turner, 2011) hold its impact on local ecological knowledge (Paper III, IV). As for environmental variables, ethnobotanical studies explore the relationship between the availability of plants through abundance and ecological dominance in comparison with plant usefulness (Lucena, Araujo, & Albuquerque, 2007). A growing number of studies have emerged by looking at specific categories of plants such as weeds (Stepp & Moerman, 2001; Zimdahl, 2007) and underutilized and neglected species (Hunter et al., 2019) as part of human medicine and source of nutrition.

Ethnobotany employs several methods including participant observation by participating in the daily routine of the community the researcher aims to study (Nolan & Turner, 2011), structure, semi-structured, unstructured individual interviews, participatory workshops as part of participatory methodology (Albuquerque et al., 2017). Each method employed vary by its depth of information obtained from the interviewee reaching from very quantitative approach (e.g., structured questioners) to qualitative research (e.g., participatory observations) (Albuquerque et al., 2019). To add, studies suggest to employ a strategy of involving local community members and researchers in collecting ethnobotanical data (Paniagua-Zambrana et al., 2018). Free-listing is another term used in ethnobotanical studies as a tool to analyse culturally most important element of the study item. The technique is part of an interview, where the researcher would ask the interviewee to list all known items of the research subject, e.g., medicinal plants (Albuquerque et al., 2017). Although, scholars note underrepresentation if only free-listing technique is used and recommends to combine the methods of semi-structured interviews and free-listing to gain throughout overview of the traditional knowledge documented (Zambrana et al., 2018). Another representing activity as part of ethnobotanical fieldwork is the collection and identification of listed plants which serve as reference material (Martin, 1995). To add, legal and moral ethnical principles are yet another core aspect included in ethnobotanical studies and shall be strictly paid attention (Albuquerque et al., 2019), e.g., informant consents (Albuquerque et al., 2017). As an example, the Code of Ethics of the International Society of Ethnobiology encloses numerous principles and is followed by the researchers in ethnobotanical studies (Pieroni, Hovsepyan, Manduzai, & Sõukand, 2020; Zank, Ludwinsky, Blanco, & Hanazaki, 2019). However, scholars note that “despite a well-marked political direction, we know that the absorption of such principles by ethnobiological researchers is still timid” (Zank et al., 2019, p. 237).

The previous notes are only part of the flavour of what ethnobotany as a discipline holds. Martin (1995) stresses the multidisciplinary nature of ethnobotany by listing six disciplines which contribute to an ethnobotanical study, namely: botany, ethnopharmacology, anthropology, ecology, economics and linguistics.

To add, scholars stress the diminishing process of traditional knowledge across numerous regions (Reyes-García et al., 2013). Migration, urbanization, interruption of oral transmission of traditional knowledge from elderly to the younger generation (Pieroni & Sõukand, 2017), forced displacement of traditional communities and rapid purchasing process of lands (Ramirez, 2007) are only some of the reasons behind the loss of traditional knowledge and active practice.

Ethnobotany and ethnobiology hold a space to broaden the discipline, for example, Jacob and Albuquerque (2020) point out that there is yet gap in ethno-culinary uses such as processing techniques in ethnobotanical studies. A recent study adds future research perspectives, including the recommendation to integrate more actively ethnobotanical research in practical domain, particularly in regard to the policymaking process (Albuquerque et al., 2019). Studies also point out that future ethnobotanical studies shall also critically reflect on how the knowledge is produced and if the chosen approach is in line with the questions asked (Albuquerque & Hanazaki, 2009).

Due to the diversity of ethnobotanical studies, the following section will include few studies (Box 4–7) selected by the author, including case studies where ethnobotany plays a role in natural resource management initiatives. The cases are only illustrative examples and do not tend to provide the best practice of ethnobotanical study. Each case study will include geographical coverage, the form of data collection and the main conclusions. The author of the thesis work has collaborated on various subjects with the authors from the North-Eastern Albania case study (Box 6) and first, second, fourth and last from the final case regarding tree saps (Box 7).

**BOX 4**

**Title:** "Participatory ethnobotany and conservation: a methodological case study conducted with *quilombola* communities in Brazil's Atlantic Forest"

**Authors:** Rodrigues, E., Cassas, F., Conde, B. E., da Cruz, C., Barretto, E. H. P., dos Santos, G., Figueira, G. M., Passero, L. F. D., dos Santos, M. A., Gomes, M. A. S., Matta, P., Yazbek, P., Garcia, R. J. F., Braga, S., Aragaki, S., Honda, S., Sauini, T., da Fonseca-Kruel, V. S. and Ticktin, T.
**Published:** 2020
**Location:** Brazil
**Method(-s) applied:** participatory ethnobotany, adaptive management

The study represents a close collaboration between local community members and researchers with the purpose to document local plant uses (Rodrigues et al., 2020). The authors provide a throughout methodology of the research process, including the integration of community members (ibid.). The first phase mainly involved establishing collaboration and gaining the understanding of community interests and goals (ibid.). Phase two included practical activities including collection of ethnobotanical data by the local community members, production of informative materials and continuous communication with the participants (ibid.). The last two phases were linked with developing the management plan for the selected species (ibid.). The study provides a list of guiding points of which the following stood out: "if a project does not address the needs of local residents, its outcomes will likely be ignored" (p. 9).

**BOX 5**

**Title:** "The ethnobotanical importance and conservation value of native plants in eastern Arabian Peninsula"

**Authors:** Heneidy, S. Z., Halmy, M. W. A., Bidak, L. M.
**Published:** 2018
**Location:** Eastern Saudi Arabia
**Method(-s) / materials applied: a** sampling of the vegetation, review of ethnobotanical studies

The study aims to investigate the native plants of the study area through ethnobotanical and conservation perspective (Heneidy et al., 2018). Two indexes were applied: species conservation index based on importance criteria, e.g., life form, conservation status and ethnobotanical relative importance index based on the number of uses (ibid.). The study suggests the need to integrate ethnobotanical data while discussing conservation actions as there might be cases where conservation importance for certain plants might be low but hold high ethnobotanical importance (ibid.).

**BOX 6**

**Title:** "The disappearing wild food and medicinal plant knowledge in a few mountain villages of North-Eastern Albania"

**Authors:** Pieroni, A., Sõukand, R.
**Published:** 2017
**Location:** North-Eastern Albania
**Method(-s) applied:** ethnobotanical fieldwork

The study aimed to document folk knowledge regarding the use of the wild plant as medicine and source of nutrition as well as compare the gained results with other ethnobotanical surveys from the region (Pieroni & Sõukand, 2017). New and previously unknown uses were identified through the comparison of the existing studies (ibid.). Additionally, the authors noted that the study results "supports the idea that territories which are less economically advantaged may retain more ethnobotanical knowledge than other, more "developed" ones" (p. 58).

**BOX 7**

**Title:** "Uses of tree saps in northern and eastern parts of Europe"

**Authors:** Svanberg, I., Soukand, R., Luczaj, L., Kalle, R., Zyryanova, O., Denes, A., Papp, N., Nedelcheva, A., Seskauskaite, D., Kolodziejska-Degorska, I., Kolosova, V.
**Published:** 2012
**Location:** Northern and eastern part of Europe
**Method(-s) / materials applied:** ethnographic data, travellers accounts, ethnobotanical fieldworks

The study provides a throughout overview of tree sap practice across Bosnia and Herzegovina, Belarus, Bulgaria, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Latvia, Lithuania Norway, Poland, Romania, Russian Federation, Sweden, Slovakia, Slovenia, Ukraine, Scotland and England (Svanberg et al., 2012). More than twenty tree species are discussed by its preservation and uses including *Acer platanoides* L., *Pinus sylvestris* L., *Salix* spp., *Betula pendu*la Roth (ibid.). The study notes that nutrition and medicinal uses stand as the main application across the study region (ibid.). Authors of the study conclude that for the Baltic countries as well as Russia, Ukraine and Belarus the practice of using tree sap is yet vivid (ibid.).

In the presented case studies, the output *co-created* with the community members are linked with the knowledge gained throughout the time and shared through generations. In this respect, the author of the thesis would like to re-call that citizen science (except co-created$^{cs}$ activities as identified in the previous chapter) provides a snap-shot at that particular time throughout the period of the project. Whereas ethnobotanical knowledge from the community members, most of the cases are build up during the lifetime and most of the time shared with the researchers at the later stage of the life-time.

### 1.1.4. Co-creating knowledge as part of sustainable development

The sixth Global Environment Outlook (UN Environment, 2019) emphasizes the value and opportunity of citizen science and local knowledge in respect to sustainable development. Sustainable development as a term was defined by the World Commission on Environment and Development back in 1987 (Brundtland Commission, 1987). Besides the commonly used definition in respect to future generations, the Commission also adds that: "Sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs" (ibid.). As a continuity for enhancing sustainable development across the globe, the Agenda

2030 for Sustainable Development includes 17 SDGs with 169 targets (UN General Assembly, 2015). Besides the goals and targets, the document also lay statements which emphasise the following: “it is an Agenda of the people, by the people and for the people – and this, we believe, will ensure its success” (ibid., p. 12). The SDGs are wide by its nature and sets on environmental (e.g., biodiversity), social (e.g., education) and economic dimensions (e.g., poverty). However, in 2019, the SDGs report notes that: “It is abundantly clear that a much deeper, faster and more ambitious response is needed to unleash the social and economic transformation needed to achieve our 2030 goals” (United Nations, 2019, p. 2).

While discussing the link between local knowledge and natural resource management and conservation activities, scholars add that “to be successful it is absolutely necessary to make people active participants, not simply integrate and validate local knowledge” (Carvalho & Frazão-Moreira, 2011, p.11). Moreover, the study of Fox et al. (2017) provides us with prerequisites for community involvement in nature restoration activities of which intellectual and spiritual presences are listed among the physical process. Szałkiewicz et al. (2020) note that the case provided by Fox and his colleagues is “an example of fair relationship between scientists, local communities, management authorities and indigenous people” (p. 9).

It is also relevant to note that citizen science and ethnobotany are not a solution for all related questions but must be viewed as a complementary tool. As for each process, there are both pros and cons. For example, public participation in the decision-making process is time-consuming and viewed as a disadvantage (Wouters, Hardie-Boys, & Wilson, 2011). Additionally, if the involvement of public is done in a poor manner (e.g., without proper training for the involved personnel), this might reflect on the future activities as the participants might not be keen of joining the process based on the previous experience (ibid.).

# 2. CHAPTER

## 2.1. MATERIAL AND METHODS

*"Since all models are wrong the scientist must be alert to what is importantly wrong"*
*(Box, 1976, p. 792).*

The following chapter will provide an overview of the various methods applied for each of the peer-reviewed papers, which serves as a base for the dissertation. Due to the interdisciplinary nature of the dissertation, the methods employed come from both social and natural sciences thus the author of the thesis divides the methodology in following sections: field and desk research as well as including section on the workshop done as part of citizen science study. The reader is guided through the ethnobotanical expedition, stakeholder mapping exercise and data analysis. The final section of data analysis is divided into two paragraphs based on the core subject: ethnobotanical data and citizen science studies. Figure 2 represents the division of the methods used for each study in order to answer the research aim.

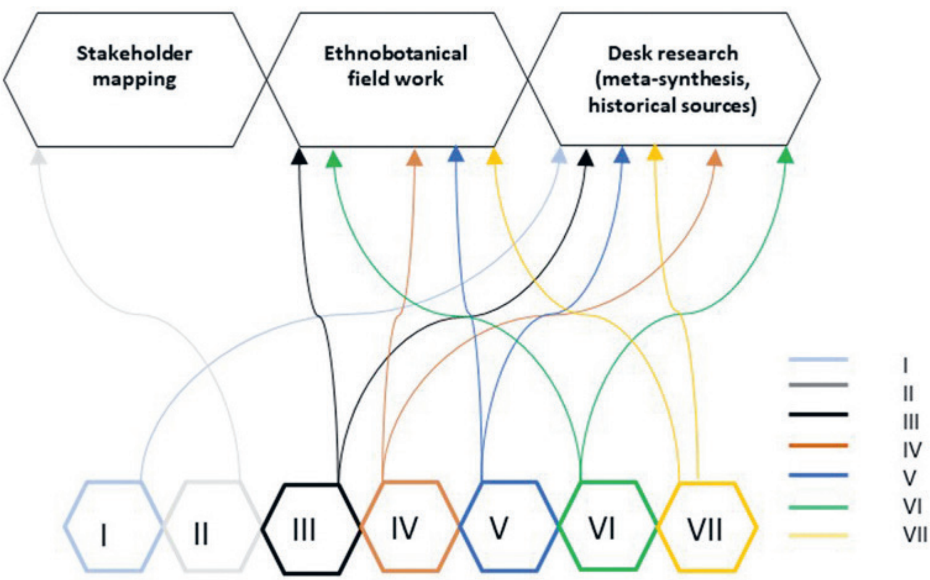



**Figure 2.** The approaches used to arrive to the study results. I–VII represents the number of the authors study.

### 2.1.1. Field research (Paper III–VII)

Ethnobotanical research took place in Latgale (Latvia) during summer 2017 (Picture 2). Ethnobotanical data were recorded from 27 villages across Dagda municipality including two villages next to the municipality border. The study region holds diversity in cultural (e.g., numerous minority groups) and socio-economic dimensions (e.g., economically disadvantaged in comparison to the rest of Latvia) thus served as a perfect study site in exploring the diversity of local knowledge and practices. Paper III and IV provide a throughout overview of the study region.

**Picture 2.** Typical landscape of the study area. Credit: IM & RS

The ethnobotanical fieldwork took place 7 days and was organized and lead by the author of the thesis work. The fieldwork involved semi-structured interviews in combination with free-listing technique (Picture 3). The interviews focused on wild plant application as food use (Paper III) and plants as medicine (Paper IV). The construction of the questions are based on numerous studies, including Łuczaj et al. (2012), Svanberg et al. (2012) and Pieroni et al. (2015). The questions were phrased in the following manner: *What wild plants and in which way are you consuming for food, e.g., as a soup?* Similarly, the structure is organized for questions regarding plants as medicine. *E.g., Which plants do you use for medicinal purposes to treat stomach-pain in childhood?* The interviewees were asked to specify in which time period the plant is used, namely, nowadays or in the past. Besides the uses of wild plants, the information about informants was also asked including year and place of birth, informants life migrations, education, occupation.

**Picture 3.** During the interview with a beekeeper. Credit: IM

The interviewee team was bi-lingual and covered a diversity of expertise including but not limited to folkloristic studies and plant biology. Due to the multi-lingual nature of the region, the interviews were conducted either in Latvian or Russian. The informants were selected based on two approaches: snow-ball and random sampling.

Informed oral consent was obtained from all the interviewees. The fieldwork proceeded in accordance with the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology, 2006). The interviews lasted from half an hour up to 2 hours. In total, 72 interviewees reported wild food use from which 69 provided information of plant remedies—most of the interviewees born in the 1950s with the eldest born in 1936. A slightly higher percentage of informants were women both for food and medicinal reports, 63% and 67% respectively.

Voucher specimens (Picture 4) were collected during the walks with the interviewees whenever possible and deposited at the Estonian University of Life Sciences herbarium (TAA), bearing numbers LGA001-120 and herbarium numbers TAA0146373-495.

**Picture 4.** Preparation of herbarium. Credit: BP

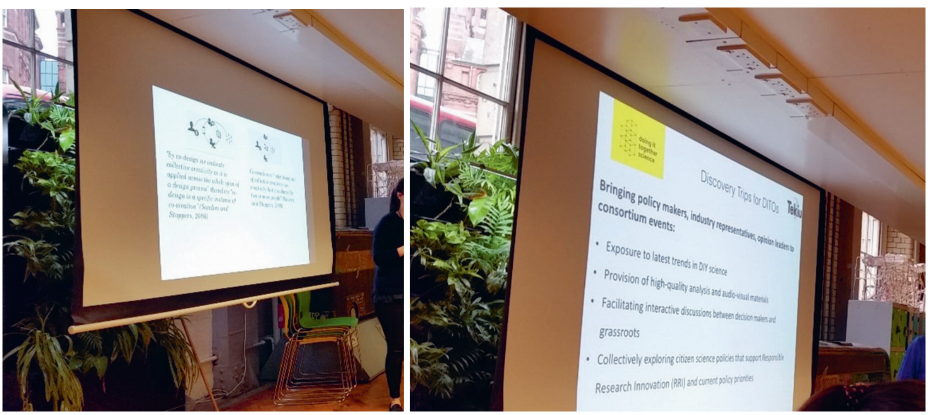
The dry specimens (Picture 5) are deposited at the Herbarium of DAIS at Ca' Foscari University of Venice (UVV), bearing numbers UVVDLGA001-71.

**Picture 5.** Dried teas (on the left) and collected dried specimens (on the right). Credit: BP

Taxonomic identification, botanical nomenclature, as well as family assignments followed the Flora Europaea (Tutin et al., 1964–1980), The Plant List database ("The Plant List," 2013), and the Angiosperm Phylogeny Group IV (Stevens, 2017). Paper III, IV and V provided a detailed methodological description of the fieldwork in the study area. Paper VI and VII include data of ethnobotanical investigation from additional research sites in Finland, Russian Federation, Estonia, Lithuania, Belarus and Ukraine following similar fieldwork protocol conducted by other researchers.

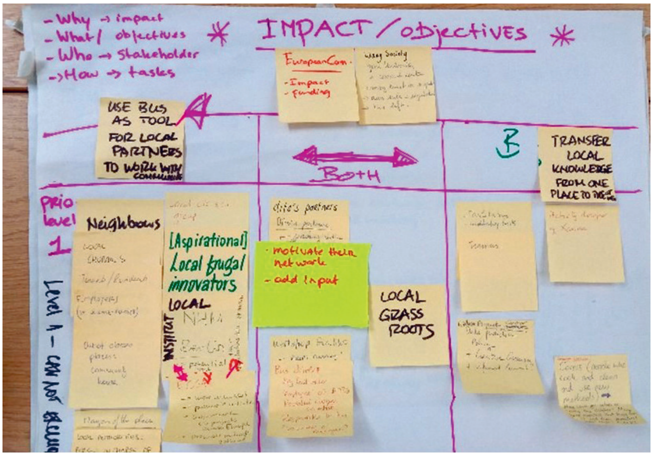
### 2.1.2. Stakeholder mapping exercise (Paper II)

The two-day workshop took place at University College London on 20th and 21st of March 2017 with the aim to practically apply stakeholder mapping method and explore its applicability for co-created citizen science initiatives. The participants (in total 27) for the mapping exercise were invited to the event based on their experience in the field. In total, nine European countries were represented: Estonia, Latvia, Lithuania, United Kingdom, Germany, France, Netherlands, Poland, and Hungary. The workshop was designed in the matter to first provide an overview of the concepts used for the participants: co-creation, "Doing it Together science" (DITOs, n.d.) project and existing stakeholder mapping cases; and then proceed with the actual task (Picture 6).




**Picture 6.** First day: introduction to the concepts. Credit: BP

After the introduction part, the participants were requested to select three co-created citizen science initiative from DITOs project (Co-Lab workshop, Into The Night project, DITOs Science Bus) which would serve as a base for stakeholder mapping exercise (Picture 7). Participants were divided for each case study, and they themselves were free to choose the level of detail for mapping the stakeholders, e.g., based on stakeholder influence or summarising a list of stakeholders. The exercised followed several guiding documents, including work of Göbel (2017) and Durham et al. (2014). Although stakeholder mapping is highly acknowledged, there is yet a limited number of stakeholder mapping with respect to citizen science projects (Paper II). The full methodological approach is described in Paper II.




**Picture 7.** Part of the mapping exercise. Credit: BP

The results were presented at the end of the second workshop day and summarised by the organizers, including the author of the thesis. As demonstrated in Paper II, for analysing the inductive data reasoning technique was employed making generalised statements based on specific cases.

### 2.1.3. Desk research (Paper I–VII)

#### *2.1.3.1. Data analysis – ethnobotanical data*

Ethnobotanical data obtained from the local community members were entered in Microsoft Excel sheets and structured in two main categories: food and medicinal application. The data were structured based on reported details by the interviewees such as plant parts used (e.g., flowers, leaves, roots, aerial parts), preparation (e.g., boiled, topical application, dried), local plant names. The analysis presented detailed-used reports multiplied by the number of respondents mentioning the particular use. Use Instances (UIs) based on emic categories was also calculated. The emic categories of food included – salad, used under bread, snacks. As for medicinal use, the number of emic categories reached over 100 including uses against heart problems, burns, earache. Jaccard Similarity Indices (JI) were calculated for used taxa following González-Tejero et al. (2008): $JI = (C/(A+B-C))$ where A represents the number of taxa in sample A, B is the number of taxa in sample B, and C is the number of taxa common to A and B. The resulting number provides the overview of the similarities between the groups in interest. The ethnobotanical data was also analysed based on two main time divisions: 1) past, including temporal, uses and 2) current uses. Past uses referred to applications which were used previously but no longer practised due to several reasons such as loss of the plant, use of medication from the pharmacy, to name few. Current uses – referred to the application which are practised throughout life and has a continues to use now.

For comparative purposes, the interviewees were divided into three groups (Latgalians, Old Believers, Mixed group) based on numerous criteria such as religious fate, language spoken to name some. A detailed description of the analysis provided in Paper III, IV.

Additionally, besides the analysis of ethnobotanical data, Paper V, VI and VII are heavily based on literature review from ethnographic, ethnobotanical, popular literature and environmental studies. As for example, in order to analyse ethnobotanical data for the purpose of understanding plant and human relationship various categorization tools were employed including Kukk (1999) approach to plant categorization, Priedītis (2014) encyclopaedia of Latvian flora and Gavrilova and Šulcs (1999) vascular plant catalogue.

#### *2.1.3.2. Data analysis – citizen science studies*

Meta-synthesis methodology was applied to study citizen science as part of various disciplines with a focus on social sciences and humanities. Meta-synthesis allows to create a holistic understanding of the issue in hand and serves as a qualitative research method (Paper I). Five guiding research questions and fourteen analytical units framed the analysis of the identified papers. Two research databases were employed: Clarivate Analytics Core Collection and EBSCOhost research databases. Pre-identification of the selected papers based on the chosen keywords reached a number of 2736 records with the final sample of studies for the analysis shorten to 62. The methodology integrated both analysis and interpretation of the gained results. Paper I includes a detailed description regarding the selection of the publication for the analysis.

# 3. CHAPTER

## 3.1. RESULTS AND DISCUSSION

*"(…) what is traditional about traditional ecological knowledge*
*is not its antiquity, but the way it is acquired and used"*
*(Batiste and Henderson (2000) cited from Berkes and Fikret (2008)).*

Each study encompassed in the dissertation is interconnected through two main themes: 1) *co-creation* of knowledge and 2) people and nature relationship, particularly with plants. The following chapter aims to provide the reader with the key findings of each study and introduce the related aspects towards *co-creation* of knowledge, sustainable development and environmental science. Each study begins with outlining the main findings from the original research followed by the discussion. Figure 3 represents the interconnection between the studies and the link with the core themes.

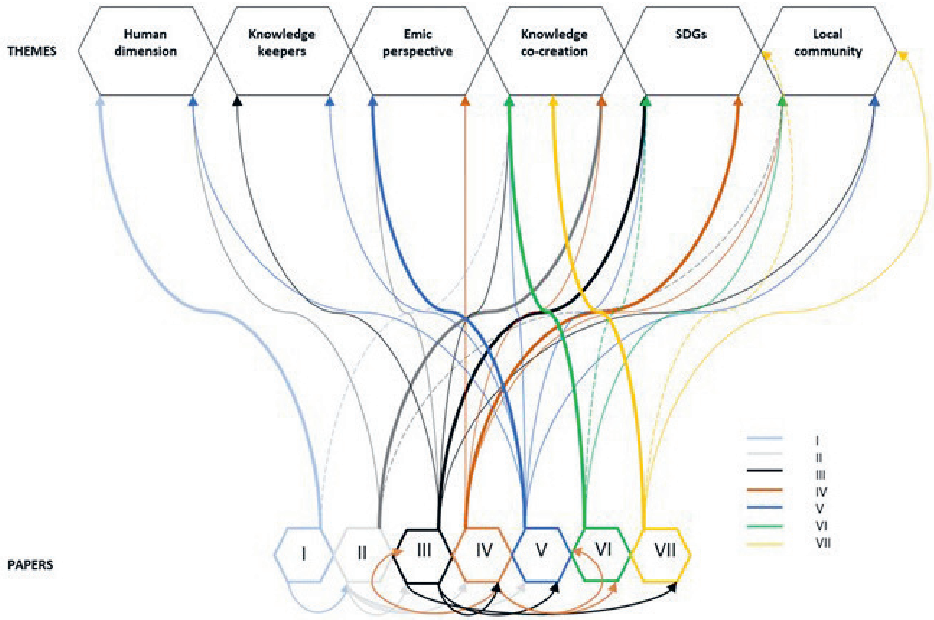



**Figure 3.** The inter-connection among the themes and authors study (I–VII).
Each study holds its own colour. The thicker the line – the higher the connection with the theme in interest

### 3.1.1. The power of interdisciplinarity (Paper I)

In Paper I the core results by analysing citizen science studies from social science and humanities perspective was the **underutilization** of these disciplines in citizen science studies. For example, most of the citizen science studies under the natural science research domain did not reflect on the role of citizen scientists (Paper I). And although high interdisciplinarity was recognized in citizen science studies classified under social science research domain the recognition of social science (e.g., reflection on the benefits for citizen scientists) was yet highly invisible (ibid.).

The results indicate that the methodological approaches used from social science and humanity components in citizen science projects categorized under natural sciences include online webinars and educational events while engaging with participants, to name few (ibid.). To add, the social science methods in natural science studies were rather **evaluation-oriented,** e.g., questioners used to address educational progress or participant motivations (ibid.).

As for citizen science projects categorized under social science, the results suggest that "the conceptual frameworks drawn from the social sciences helped to **provide more weight** to local people's knowledge, the expertise of the embodied experience, the situatedness and coproduction of transdisciplinary knowledge (SSP14) and contributed to creating an argument of trust around non-expert knowledge (SSP12, SSP22)" (Paper I, p. 5). Additionally, questioning how specific processes such as co-creation can contribute to answering social needs been addressed in citizen science projects under social science (ibid.).

As identified in the Paper I, from citizen science studies in humanities domain the need to integrate citizen science is described in the sense that it "may help to save primary historical sources" (p. 6). Other arguments reflected in the Paper I include that "the reasons for using CS are increased coverage, **access to unpublished sources** scattered almost all over the world and access to local knowledge of natural resources in a specific region (HP1)" (ibid., p. 6). The detailed results of the social science and humanities with respect to citizen science project are outlined in Paper I.

#### *3.1.1.1. The link of main findings to co-creating knowledge*

The author of this dissertation stresses the benefit of human dimensions while discussing the knowledge *co-creation* process in natural resource management. As for example, the methods and theories employed in social sciences and humanities may enhance a deeper understanding of the issue in hands. Paper I (p., 8) in respect to citizen science and natural science studies adds that: "A closer link to social sciences may enrich the theoretical framework and set of methodologies to solve the wicked problems of the sustainability turn which are often linked to different interests, perceptions, or routines." As emphasized by Berkes and Fikret (2008): "(…) human society consists of a great many groups, as different from one another as the city dwellers of New York, rice farmers of India, and aboriginal hunters of northern Canada." Berkes and Fikret (2008) add that people also differ by the way how "they view the world around them." The previous notes contribute to the argument why the subject of human dimensions is so relevant on various scales while discussing our natural resources.

#### *3.1.1.2. The link of main findings to environmental science and sustainable development*

The author of the thesis work would like to borrow a quote from Bhutan Institute of Himalayan Studies (n.d.) which notes the following: "A wining day for achieving sustainable development goals will be when humans accept the fact that we must co-exist with nature to exist on this planet." The respect to human dimensions has been frequently mentioned across academia and by the practitioners. As identified in the recent review paper by Charnley et al. (2017), social science may contribute in the natural resource management process by generating "decisions that are more appropriate to a particular social-ecological setting" (Charnley et al., 2017, p. 81). However, as the research findings of Paper I identifies, there is yet a great deal of potential to be exploited.

While discussing the human dimension in respect to sustainability scholars such as Seghezzo (2009, p. 550) note the work of the American author K. Wilber: "he believes that without some kind of 'marriage' between modern knowledge and pre-modern wisdom 'the future of humanity is, at best, precarious' (Wilber 1998, 4–10)." To this respect, social science provides the ground to merge various forms of knowledge. As pointed out by Charnley et al. (2017), the difference between natural science and social science lays in how the world is understood, to name one distinctness. As for example, social science most of the time is "emphasizing the importance of presenting multiple perspectives and voices" (ibid., p. 86) whereas natural science "primarily draw upon a realist ontology (only one reality exists)" (ibid.p.81). **Therefore,** the following section will provide an understanding of **whose voices are to be heard** and how to define them.

### 3.1.2. Emphasis on co-creation through stakeholder mapping (Paper II)

In research paper II three citizen science projects (Co-Lab workshop, Into-the-Night and Science Bus) used for stakeholder mapping exercise employed a diversity of character such as different goals for the exercise and diversity of the ways for mapping the stakeholders (Paper II, Table 1).

As identified in Paper II, for Co-Lab workshop, the main goal for stakeholder mapping was to improve the activity through the reflection of the past event. Into the Night project, the main goal was a reflection on the activities performed already and as a source for future perspectives for the upcoming events (ibid.). The stakeholder mapping exercise for the Science Bus project was used as part of planning the activity due to the reason that the Science Bus was in the preparation phase during the workshop period (ibid.).

Regarding the way of mapping the stakeholders for Co-Lab workshop, it was based on the retrospective approach as the activity was already taken place (ibid.). Into the Night project had already begun its implementation through the pilot activities and thus, the mapping exercise employed both retro- and prospective mapping (ibid.). A prospective mapping approach was used by the participants working with the Science Bus project. The common line was the co-creation approach in all three citizen science projects; and its link to DITOs project (ibid.).

**Table 1.** The case studies used for stakeholder mapping exercise

| Co-Lab workshop | Into-the-Night | Science Bus |
|---|---|---|
| Co-Lab workshop activities employ co-creation form. The activities involve an interdisciplinary approach covering a variety of subjects: synthetic biology, design and art. The contributors are requested "to co-create new knowledge and novel solutions" (Paper II, p. 3) with respect to environmental and social issues. The Co-Lab workshops are organised by the Open Science School and took place in December 2015 (Paper II). Nine Co-Lab workshops had already taken place worldwide in Paris, London, Beijing, to name some, by the time the stakeholder mapping was organised (ibid.). Each workshop activity is "unique, driven and co-directed by different participants" (Paper II, p. 3). | Earthwatch Europe and University College London lead a citizen science project named – Into the Night. The project aims "to increase public engagement in the UK on major environmental issues" (Paper II, p. 4). The project takes place in the United Kingdom and linked to the question of light pollution (Paper I). The activity involves the collection of light and noise pollution data and collaborative workshops with the participants by developing do-it-yourself tools for data collection through citizen science (ibid.). By the time of stakeholder mapping exercise, the project had already passed the pilot phase (ibid.). | In July 2017 Waag Society launched the Science Bus travelling exhibition. The bus visited 11 countries, including Italy, Spain, Greece, to name some. "Its planned topics ranged from health, food, and the environment, with activities described as aiming to pique curiosity and explore science" (Paper II, p.4). Co-creating a knowledge "diary" (ibid., p. 4) as well as collaborating with the participants by creating do-it-yourself tools, e.g., phone chargers, were part of the activity. At the time of the stakeholder analysis exercise, the Science Bus was at the planning phase (Paper II). |
| More information: http://openscienceschool.org/biocolab/ | Blog post: https://uclexcites.blog/2017/04/27/interview-the-researchers-what-was-into-the-night/ | More information: https://togethersciencebus.eu/ |

As for Co-lab workshop, the stakeholder mapping helped to identify the missing stakeholder categories such as policymakers and community members which were missed in the previous Co-lab workshops (ibid., Table 1a).

**Table 1a.** The stakeholders involved during Co-lab workshop phases. Modified from Paper II

| Phases | Blooming & Ideation | Planning | Execution |
|---|---|---|---|
| **Stakeholders** | • Civil society (NGOs, trade unions, think tanks)<br>• Science (scientists, public/private research institutions, other experts)<br>• Business (entrepreneurs) | • Civil society (associations)<br>• Science (scientists, research groups, students, admin staff)<br>• Artists<br>• Designers | • Science (biologists)<br>• Designers<br>• Others with relevant skills |

The participants working on mapping the stakeholders for Into the Night project divided the stakeholders based on three levels: 1) existing and 2) potential contributors, 3) stakeholders affected by the project (ibid.). Each of the groups was further divided based on their level of influence and interest (ibid., Figure 4). However, the topic of influence held a rather lengthy discussion on what exactly influence means in the context for this particular project (ibid.).

As for the Science Bus the participants grouped the stakeholders following two of the listed goals of the project: 1) Science Bus – as a tool for working with the community; 2) Science Bus – as a tool for transferring the knowledge (ibid., Figure 5).

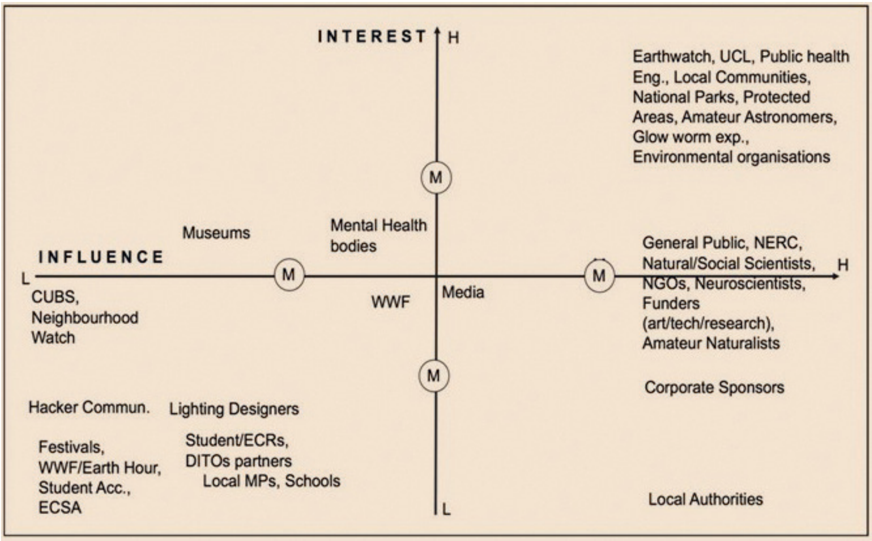



**Figure 4.** Into-the-Night stakeholder mapping with existing contributors (right side) and potential contributors (left side). The level of interest and influence: low (L), medium (M), high (H). Modified from Paper II

| | Science Bus, as a tool for working with local communities | ← Both → | Science Bus, as a tool for transferring local knowledge |
|---|---|---|---|
| Level 1 | Neighbours, local churches, residents organisations, employers, out-of-class places, community houses<br>Local authorities, mayors<br>ECSA, local innovators, local citizen science groups, local institutions | DITOs partners<br>Workshop facilitators, bus driver<br>Local grassroot communities | Facilitator, workshop hosts, trainers<br>Activity Designer<br>Property Owner<br>Carers |
| Level 2 | Schools, school holiday organisers<br>Internet based DIY science community, bloggers | Local press, journalists, local newsletter producers<br>Who goes camping?<br>Funders (H2020, private, Public)<br>Bus Sponsors | Sense Box Minister (CS project no DITOs partners)<br>Retirement home<br>My dad (retired scientist) |
| Level 3 | Insurances<br>Local gathering spaces (bars, sport centers, youth centers)<br>Libraries, neighbours, local suppliers, market stall owners, shop owners, police, gangs, …. | X | X |

**Figure 5.** The results of stakeholder mapping for Science Bus. Three levels of importance are introduced: essential for the project (Level 1), important for the project (Level 2), least important (Level 3). Modified from Paper II

As identified in the study results, for each goal, a rather different list of stakeholders was named and introducing new stakeholder categories previously not named for the other cases, e.g., property owners (ibid.).

Paper II adds that in all three groups, funders were introduced as one of the key stakeholders. Additionally, the participants questioned the influence of shaping the activity through the funder as well as the **continuity of co-creation initiatives** when the funding might be limited (ibid.). Additionally, communication was central for all three projects by participants stressing that "the communication with stakeholders was deemed to be a problematic element of existing projects, and this was thought to be significantly improved by using stakeholder mapping early in the project to identify **who should communicate with whom and when** (Reed 2008; Reed et al. 2009)" (Paper II, p.8). Additionally, the role of moderators was highlighted for Co-Lab and Science Bus activity (ibid.). The detailed results, including figures based on the data from the workshop, are listed in Paper II.

#### *3.1.2.1. The link of main findings to co-creating knowledge*

The author of the thesis notes three discussion points based on the study results: funding and its link to co-created citizen science activities, the importance of communication in citizen science projects and the benefit of collaboration in the interdisciplinary team.

The stakeholder group of **funding organisations** provides a ground for a discussion on the **influence on co-created citizen science projects** as previously noted. Academia discusses the impact of grant programmes to the researcher work; the author of the thesis proposed that it is yet, a valid discussion point also for citizen science projects as international project tenders approach citizen science including co-creation aspect, e.g., Co-creation for growth and inclusion (H2020 2016–2017), Grounding RRI in society with a focus on citizen science (H2020 2018–2020).

For example, scholars note that in-depth reflections are pressured by the limited time due to the existing grant culture (see: Lilienfeld, 2017). Even strikingly, Lilienfeld (2017, p. 663) notes that "the grant culture has almost certainly led many scholars to abandon daring lines of work that are less fundable and to pursue safe lines of work that are more fundable." On the other hand, there are also cases of unfunded Nobel-level research or with no extra funding besides the basic salary (Tatsioni, Vavva, & Ioannidis, 2010). However, as mentioned by Nobel Laureate in the field of medicine – "Much Nobel work would not have got past peer review – that is the essence of Nobel research!" (ibid., p.1337). Although the provided arguments from the scholars are outside the domain of citizen science, they are yet highly relevant to question the effect of grant programs on the long-term sustainability of these activities.

Earlier studies also confirm that the communication part in citizen science initiatives is essential (see: Roy et al., 2012). To add, the communication strategies do not limit itself to dissemination activities only but also include setting up discussion forums to link participants with scientists, to name some examples (Golumbic, Baram-Tsabari, & Koichu, 2019). In one of the guiding documents of communication aspects in citizen science projects, the authors note that "**95% of citizen science is communication**" (Veeckman, Talboom, Gijsel, Devoghel, & Duerinckx, 2019). Also, Hecker et al. (2018c) note the importance of communication listing seven recommendations, including the attention to time and resources for communication in citizen science projects.

As part of the case studies being co-created[cs] activities, the stakeholder mapping itself (Paper II) was an exercise for learning various approaches together with numerous participants from different backgrounds. Such an approach brought questions which might have not been put on if the organizers of the activities alone would have been taking part in stakeholder mapping.

#### *3.1.2.2. The link of main findings to environmental science and sustainable development*

The study presented in Paper II points out the importance of the mapping stakeholders. Although Paper II focused on co-created[cs] activities, there are numerous examples where stakeholder analysis is in-use in respect to sustainability questions. Hemmati (2002, p. 3) notes that "Agenda 21 is the first United Nations (UN) document (United Nations Sustainable Development, 1992) to address extensively the role of different stakeholders in the implementation of a global agreement." As for Agenda 2030 Fox & Stoett (2016, p. 555) adds that: "2030 Agenda process has opened new paths toward the establishment of global democratic governance, through we remain far from the ideal participatory democracy many would prefer to see." Reed et al. (2009, p. 1947) point out "that stakeholder analysis can lead to the design of strategies and processes that more effectively represent and involve stakeholders in environmental decision-making processes." Although frequently the defining aspects of stakeholder are "interest" (e.g., Hemmati, 2002) we also need to pay attention as noted by Reed et al. (2009) to the ones holding power to influence the decision even if holds no interest. To add, stakeholder engagement in sustainable development aspects also holds numerous challenges. Filho and Brandli (2016) summarise the following problems associated with stakeholder engagement: conflict of interest, lack of capacity, stakeholder fatigue, to name some.

In order to introduce the reader **closer to certain knowledge keepers**, the following section will focus on the local community and their knowledge and practice with respect to plant uses as a remedy and source of nutrition.

### 3.1.3. Local knowledge of wild food plants and plants as medicine (Paper III and IV)

The study presented in Paper III and IV involves ethnobotanical research in Latgale. Ethnobotanical data from Latgale holds diversity in terms of studying the relationship between plants and people (Paper III, IV, Picture 8).

**Picture 8.** A snap-shot of the variety of local practices. Credit: RS, IM, IH

As to regards with food, plant uses the total number of taxa used reached slightly over 70 (Paper III) whereas for medicinal plants, the taxa the number was higher – 116 (Paper IV). The most used families among food were – Rosaceae, Ericaceae, Polygonaceae, Betulaceae and Apiaceae (Paper III). For medicinal plants, the families with the highest number of uses were the following – Asteraceae, Rosacea, Betulaceae, Ericaceae and Lamiaceae (Paper IV).

On the taxa level, the most common specie as food use was – *Vaccinium myrtillus* L. (83 DUR) (Paper III) whereas for medicinal application – *Betula* spp. (59 DUR) (Paper IV). The results of the ethnobotanical expeditions reveal that the various uses of food plants are not characterised as a recreational activity but rather as a **search for an additional source of nutrition** (Paper III, Table 2).

**Table 2.** Part of food uses of plants in Dagda municipality > 10 DUR. Modified from Paper III (full list in Paper III)

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Carum carvi* L., Apiaceae (LGA061) | тмин, ķimene, kmins^, tmin^, ķimene, savvaļas ķimene, кмин | seeds | dried, fresh | condiment |
| | | | | condiment for bread |
| | | | | condiment for cheese |
| | | | | condiment for sauerkraut |
| | | | | condiment for meat |
| | | | | condiment for sausages |
| | | | | condiment for soup |
| | | | | recreational tea |
| | | | | strong alcohol |
| *Matricaria chamomilla* L., including *Matricaria discoidea DC*, *Tripleurospermum inodorum (L.) Sch. Bip.* Asteraceae (DLGA048) | kumelīte, romaška^, ромашка | flowers | dried | recreational tea |
| *Taraxacum officinale* (L.) Weber ex F. H. Wigg., Asteraceae | одуванчик, pienenes | flowers | cooked | Syrup |
| | | | fresh | Snacks |
| | | leaves | fresh | Salad |
| | | aerial parts | cooked | condiment for soup |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Betula* spp. including *Betula pendula* Roth, *Betula pubescens* Ehrh. and their hybrids, Betulaceae | берёза, bērzs | leaves | dried | recreational tea |
| | | | fresh | salad |
| | | sap | fermented | kvass |
| | | | | wine |
| | | | fresh | drink |
| | | | frozen | drink |
| | | | stored with citric acid and sugar | drink |
| | | wood | burned | bread baking |
| | | | | smoking meat |
| *Corylus avellana* L., Betulaceae (LGA005A) | lazdas, орехи лесные, орехи, орешник | nuts | fresh, dried | snacks |
| *Armoracia rusticana* P. Gaertn., B. Mey. & Scherb., Brassicaceae (LGA056) | mārrutks, хрен, mārrutki, hrens^ | leaves | fresh | condiment for pickles |
| | | | | salad |
| | | roots | fresh | condiment for meat |
| | | | | condiment for pickles |
| | | | | salad |
| *Juniperus communis* L., Cupressaceae | верес, можжевельник, paeglis, kadiķis, вересок | twigs | burned | smoking meat |
| *Vaccinium myrtillus* L., Ericaceae (LGA007, DLGA043, DLGA061) | черника, mellenes, чорные | fruits | cooked | compote |
| | | | | jam |
| | | | | drink |
| | | | cooked, frozen | dessert |
| | | | dried | recreational tea |
| | | | fresh, frozen, dried | snacks |
| | | aerial parts | dried | recreational tea |
| *Vaccinium oxycoccos* L., Ericaceae | клюква, dzērvene, dzērvenes | fruits | cooked, frozen | jam |
| | | | fresh | compote |
| | | | | condiment for sauerkraut |
| | | | fresh, frozen | dessert |
| | | | | drink |
| | | | | snacks |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Vaccinium uliginosum* L., Ericaceae | zilenes, голубика, golubnika^, golubika^, пьяница | fruits | cooked | compote |
| | | | | jam |
| | | | fresh | snacks |
| | | | juice | juice |
| *Vaccinium vitis-idaea* L., Ericaceae (LGA004, DLGA069) | брусника, brusiņika^, brusnika^, brūklenes, журавина, brūklenājs, брусничник | fruits | cooked | compote |
| | | | | drink |
| | | | | jam |
| | | | | jam with apples |
| | | | | pie with berries |
| | | | fresh, frozen | snacks |
| | | | frozen | dessert |
| | | leaves | dried | recreational tea |
| | | | fresh | snacks |
| *Ribes nigrum* L., Grossulariaceae (LGA112) | upene, черная смородина, upenes, melnās upenes, смородина, черная смородa, смородина черная | twigs | fresh | condiment for birch sap |
| | | | | condiment for pickles |
| | | | | preservative for sap |
| | | | | recreational tea |
| *Hypericum* spp. including *Hypericum maculatum* Crantz and *Hypericum perforatum* L., Hypericaceae (LGA027, DLGA030) | зверобой, зверобои, zveraboj^, asinszāle | aerial parts | dried | recreational tea |
| | | | | added to strong alcohol |
| | | | fresh | added to strong alcohol |
| *Mentha* sp., Lamiaceae including M. x piperita, M. longifolia and M. suaveolens (DLGA035) | мята, istabas piparmētra, mjata^, piparmētra, polan mjata^, savvaļas piparmētra, piparmētra, mētra | leaves | fresh | snacks |
| | | aerial parts | cooked | syrup |
| | | | dried | condiment for soup |
| | | | fresh, dried | recreational tea |
| *Tilia cordata* Mill., Malvaceae (DLGA009, LGA011) | liepa, липа, līpas* | inflorescenses | dried | recreational tea |
| *Rumex* spp. including *Rumex thyrsiflorus* Fingerh., *Rumex acetosa* L., Polygonaceae (LGA086, LGA064, LGA036, LGA121) | parastā skābene, skābenes, skābene, щавель, кислица, pļavas skābenes, savvaļas skābene, skuobines*, zirgu skābenes | leaves | cooked | soup |
| | | | fresh | salad |
| | | | | snacks |
| | | | frozen | soup |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Fragaria vesca* L., Rosaceae | meža zemene, земляника, meža zemenes, zemļenica^, zemļaņika^ | fruits | cooked | jam |
| | | | | juice |
| | | | fresh | compote |
| | | | | dessert |
| | | | | snacks |
| | | | frozen | dessert |
| | | | | snacks |
| | | leaves | dried | recreational tea |
| | | aerial parts | dried | recreational tea |
| | | | fresh | recreational tea |
| *Prunus cerasus* L., Rosaceae | ķirši, вишня | leaves | fresh | condiment for pickles |
| | | twigs | fresh | recreational tea |
| *Rubus idaeus* L, Rosaceae (DLGA012, DLGA033) | малина, meža avenes, avenes, aveņis*, maļina, dārza avenes, малинник | fruits | cooked | compote |
| | | | | drink |
| | | | | jam |
| | | | | juice |
| | | | fermented | wine |
| | | | fresh | snacks |
| | | | frozen | dessert |
| | | leaves, twigs | fresh, dried | recreational tea |
| *Acer platanoides* L., Sapindaceae | kļava, kļavas, клён, кленовый | leaves | fresh | under bread |
| | | sap | fresh, frozen | drink |
| *Urtica* spp. including *Urtica dioica* L., *Urtica urens* L., Urticaceae | крапива, стрикава, nātres, nuotras*, nātras | aerial parts | cooked | cutlets |
| | | | | dumplings |
| | | | | soup |
| | | | dried | recreational tea |
| | | | scaled | salad |

*Abbreviations: *^Russian language origin borrowed by Latgalians speakers, ^^Latgalian dialect origin borrowed by Latvian speakers; ^Latvian-speaking respondent providing Russian plant name, *Latgalian name.*

Among all used taxa for both current uses and past food uses, 12 species were no longer practised. Interviewee (women, b. 1951) noted a past use for consuming the roots of *Equisetum arvense* L. during her young age. The taste was described in parallel with nuts. Also, food from hard times such as the use of shoots of *Heracleum sphondylium* L. was named by Russian-speaking man born in the 1940s. An elderly lady born in the 1940s recalls the use of wild greens and become highly emotional due to the memories of the hard times during and after World War II (Paper III).

As for the medicinal plants, the knowledge is yet **actively practised** (Paper IV, Table 3). Of the 113 emic categories of medicinal plant uses, the following were highly represented among the reported uses: healthy (114 DUR /30 taxa), cold (63 DUR/20 taxa), stomach ache (40 DUR/18 taxa), and wounds (40 DUR/13 taxa). To add, an elderly interviewee (women, b.1938) noted that "she thinks plants are saving her life and she does not believe in doctors and synthetic medication" (Paper IV, Picture 9).


**Picture 9.** Interviewee self-made encyclopaedia (on the right) and a note book (in the middle) with medicinal plant uses, popular scientific book (on the left). Modified from Paper IV

From the plant parts used as medicine, the following were most represented: aerial parts in general (23%), leaves (18%), twigs (15%) and flowers (11%), followed by seeds, roots, etc. Also, bark was noted by the interviewees as used plant part, from for example *Quercus robur* and *Salix* spp. (Paper IV, Table 3). Tea, fresh – topical application and whisked in the sauna, hot compress and tincture were some of the most reported preparation methods for medicinal uses (ibid.).

**Table 3.** Part of medicinal plant uses in Dagda municipality > 10 DUR. Modified from Paper IV (full list in Paper IV)

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Allium sativum* L., Amaryllidaceae | ķiploki, чеснок | bulbs | eaten | healthy |
| | | | | high cholesterol |
| | | | fresh, topical application | hair care |
| | | | | toothache |
| | | | | veins |
| | | | | wounds |
| | | | tincture, massage | joint pain |
| *Carum carvi* L., Apiaceae (LGA061, LGA107) | тмин, ķimenes, ķimene, savvaļas ķimene | seeds | ground, used with honey | diarrhoea |
| | | | tea | appendicitis |
| | | | | stomach ache |
| | | | | to increase milk production in women |
| | | | | women's diseases |
| | | aerial parts | tea | appendicitis |
| | | | | post surgery |
| | | | | stomach ache |
| *Achillea millefolium* L., Asteraceae (LGA002, LGA047, LGA088, DLGA002a, DLGA002h, DLGA040) | pelašķis, pelašķi, pelešķi*, syuriņis*, parastais pelaškis^^, žyužuoni*, žyužuons*, тысячелистник, tisočulistņiks^, tisjaselistņik^, pelruškene*, кривавник, peļieji* | flowering aerial parts | tea | cold |
| | | | | headache |
| | | | | sore throat |
| | | | | stomach ache |
| | | | | tuberculosis |
| | | | | appetizer |
| | | | | diarrhoea |
| | | | | healthy |
| | | | | panacea |
| | | | | women's diseases |
| | | leaves | fresh, topical application | bleeding |
| | | | | wounds |
| | | | tea | healthy |
| | | | | lung diseases |
| | | roots | dried | joint pain |
| | | aerial parts | dried, ground, topical application | wounds |
| | | | tea | stomach ache |
| | | | tea mixture | gall-bladder problems |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Arctium tomentosum* Mill., Asteraceae (LGA017, LGA038, LGA084) | baduļka^, lielais dadzis, badzuļka^, dadzis, dodzs*, gedi^, repeņik^, badzuļi^, деды, дэдовник, лапухи, лопуха, лапух, лапухи, репейник | leaves | fresh, topical application | backache |
| | | | | bruises |
| | | | | joint pain |
| | | | | pain |
| | | | | spondylosis |
| | | | | swelling |
| | | roots | decoction | hair care |
| | | | tea | men's diseases |
| *Calendula officinalis* L., Asteraceae (LGA019, LGA050, LGA066, DLGA002f, DLGA020, DLGA045) | kliņģerītes, kliņģerīts, календула, ноготки | flowers | tea | breast inflammation |
| | | | | calming |
| | | | | diuretic |
| | | | | menstrual pain |
| | | | | sore throat |
| | | | | stomach ache |
| | | | | women's diseases |
| | | | tea, rinsing | eye infection |
| | | | | sore throat |
| | | | tea, vaginal rinsing | women's diseases |
| | | | tincture | disinfection |
| *Matricaria chamomilla* L., Asteraceae (DLGA011, DLGA023, DLGA048) | kumelīte, rumaška^, ромашка, kumelītes, romaška^, ромашечка, ramaška^, kumeleitys*, kumeļeites* | flowers | bath | diathesis in children |
| | | | decoction | hair care |
| | | | tea | antimicrobic |
| | | | | inflammation |
| | | | | appetizer |
| | | | | calming |
| | | | | cold |
| | | | | disinfection |
| | | | | fever |
| | | | | healthy |
| | | | | indigestion |
| | | | | organism cleansing |
| | | | | refreshing |
| | | | | stomach ache |
| | | | tea, rinsing | eye infection |
| | | | | sore throat |
| | | roots | decoction | hair care |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Tussilago farfara* L., Asteraceae (LGA001, LGA081) | мать-и-мачеха, māllēpe, mač i mačiha^, sātlopys*, māllēpenes,mace maceha^ | flowers | tea | cold |
| | | | | cough |
| | | leaves | cooked | soup |
| | | | fresh, topical application | bruises |
| | | | | headache |
| | | | | joint pain |
| | | | | muscle pain |
| | | | | scars |
| | | | tea | asthma |
| | | | | cough |
| | | | | medicinal |
| | | | | sore throat |
| *Betula* spp. including *B. pendula* Roth, Betulaceae (LGA095, DLGA002b, DLGA006b, DLGA070) | берёза, bērzs | buds | eaten | cold |
| | | | tea | healthy |
| | | | tincture, topical application | joint pain |
| | | leaves | fresh, topical application | headache |
| | | | | joint pain |
| | | | tincture, topical application | joint pain |
| | | sap | decoction | hair care |
| | | | fresh | vitamins |
| | | twigs | fresh, topical application | joint pain |
| | | | whisked in sauna | backache |
| | | | | healthy |
| | | | | joint pain |
| *Brassica oleracea* var. capitata f. alba DC., Brassicaceae | капуста, kāposti, kuopusti*, kāposts | leaves | fresh, topical application | bruises |
| | | | | burns |
| | | | | headache |
| | | | | joint pain |
| | | | | lumps after injections for backpains |
| | | | | sunstroke |
| *Valeriana officinalis* L., Caprifoliaceae (LGA033, DLGA034) | валерианка, валериана, валериан, baldrejāns, balderjāņi, bolderjāņi, vaļerjanka^, valerjanki^, baldriāns, baldriāņi, valerjankas^, balderiānus | roots | dried | fever |
| | | | tea | calming |
| | | | | healthy |
| | | | | insomnia |
| | | | tincture | calming |
| | | aerial parts | tea | calming |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Vaccinium myrtillus* L., Ericaceae | черника, mellenes | fruits | dried | stomach ache |
| | | | dried, frozen, tea | diarrhoea |
| | | | fresh, dried, cooked, tea | eye problems |
| | | | infused in strong alcohol | diarrhoea |
| | | aerial parts | tea | eye problems |
| | | | | medical |
| | | | | stomach ache |
| *Vaccinium oxycoccos* L., Ericaceae | Клюква, dzērvenes | fruits | fresh | thickening of blood |
| | | | | healthy |
| | | | | hypertension |
| | | | fresh, tea | fever |
| | | | fresh, topical application | earache |
| | | | drink | cold |
| | | | | fever |
| | | | tincture | cold |
| *Quercus robur* L., Fagaceae | ozols, ozoli, дуб, ūzuls* | bark | decoction | toothache |
| | | | dried | diarrhoea |
| | | | tea | diarrhoea |
| | | | tincture | healthy |
| | | twigs | whisked in sauna | healthy |
| | | | | joint pain |
| *Pelargonium graveolens* L'Hér, Geraniaceae (LGA030, LGA067) | юранина, юранька, герания, juramin^, gerānija, герань, juraņina, uramins*^, uramina^, geraņ^, мушкат, цвет юранина | leaves | fresh, topical application | earache |
| *Hypericum* spp. including *H. maculatum* Crantz and *H. perforatum* L., Hypericaceae (LGA020, LGA048, LGA060) | зверобой, зверобои, zveraboj^, asinszāle | aerial parts | fresh | wounds |
| | | | tea | cleansing blood |
| | | | | cold |
| | | | | heart problems |
| | | | | hypertension |
| | | | | indigestion |
| | | | | pain |
| | | | | panacea |
| | | | | sore throat |
| | | | | stomach ache |
| | | | tincture | liver diseases |

| Latin name | Local names | Used part(s) | Preparation | Uses |
|---|---|---|---|---|
| *Mentha sp.* (eg *M.* × *piperita* L., *M. longifolia* (L.) *Huds., M. suaveolens* Ehrh), Lamiaceae (LGA052, DLGA035) | мята, mjata^, piparmētras, mētras | leaves | fresh | bad breath after smoking |
| | | aerial parts | tea | calming |
| | | | | cold |
| | | | | healthy |
| | | | | hypertension |
| | | | | insomnia |
| *Tilia cordata* Mill., Malvaceae (DLGA009) | liepa, līpas*, liepas, липа, līpa* | inflorescences | tea | beauty treatment |
| | | | | cold |
| | | | | healthy |
| | | twigs | whisked in sauna | healthy |
| *Pinus sylvestris* L., Pinaceae (DLGA022, DLGA046, DLGA065) | сосна, priedes, priede | buds | tea | asthma |
| | | | | cold |
| | | | | cough |
| | | | tea, gargle | sore throat |
| | | | tincture | cold |
| | | | | cough |
| | | | | healthy |
| | | | | lung diseases |
| | | needles | decoction, foot bath | calming |
| | | resin | ointment | wounds |
| | | | tincture | joint pain |
| | | twigs | brought into the home | prophylactics |
| | | | decoction used for bath | healthy |
| | | | whisked in sauna | healthy |
| *Plantago major* L., Plantaginaceae (LGA062, LGA071, LGA113) | подорожник, ceļmala lapa, ceļteka, padarožņiks^, ceļmallapa, трипутник, ceļateka | leaves | fresh, topical application | bruises |
| | | | | cuts |
| | | | | pain |
| | | | | wounds |
| | | | tea | cough |
| | | | | stomach ache |
| *Primula veris* L., Primulaceae (DLGA063, DLGA021) | первоцвет, gaiļabikses, petuški^, gailīši, pervocvet, gaiļbiksītes, gaiļapieši, gaiļbiksīte | inflorescences | tea | antimicrobic |
| | | | | bronchitis |
| | | | | cold |
| | | | | cough |
| | | | | fever |
| | | | | healthy |
| | | | | heart problems |
| | | | | insomnia |

| **Latin name** | **Local names** | **Used part(s)** | **Preparation** | **Uses** |
|---|---|---|---|---|
| *Rubus idaeus* L, Rosaceae (DLGA012, DLGA033) | малина, meža avenes, avenes, aveņis*, oveņis* | fruits | jam | cold |
| | | | | cough |
| | | twigs | tea | cold |
| | | | | cough |
| | | | | fever |
| *Urtica* spp. including *U. dioica* L., *U. urens* L., Urticaceae (LGA058, LGA059) | крапива, nātres, nātras, nātre, ārtsnieciskā nātre, volk trava^, krapiva^ | leaves | fresh, topical application | boils |
| | | aerial parts | boiled in milk, topical application | for specific illness – polosņik (RU) |
| | | | decoction | hair care |
| | | | tea | body cleansing |
| | | | | healthy |
| | | | | immune boosting |
| | | | | joint pain |
| | | | | liver diseases |
| | | | | medicinal |
| | | | whisked in sauna | healthy |
| | | | | joint pain |
| | | | | promotes the bloodstream |

*Abbreviations: ^^Latgalian dialect origin borrowed by Latvian speakers; ^Latvian-speaking respondent providing Russian plant name, *^Russian language origin borrowed by Latgalians speakers, *Latgalian name.*

Besides the various plant applications, additional narrative introduced by the interviewees was the loss of certain taxa, e.g., *Carum carvi L.* (Paper III). Both of these comments provided by the interviewees enrich the ethnobotanical data giving a context and introducing new research angels such as change of landscape (see following section 4.1.5., Picture 10).

**Picture 10.** The landscape and households in the municipality of Dagda. Modified from Paper IV

As the study identifies, the differences across three social groups (Old Believers, Latgalians and Mixed group) provided additional insights of the diversity in the study region (Paper III, IV); however, the results need to be viewed as tendency due to the unequal number of people among the groups. As for the food uses the highest diversity of taxa and the use of local and traditional resources was held by Latgalian group (Paper III, Figure 6).

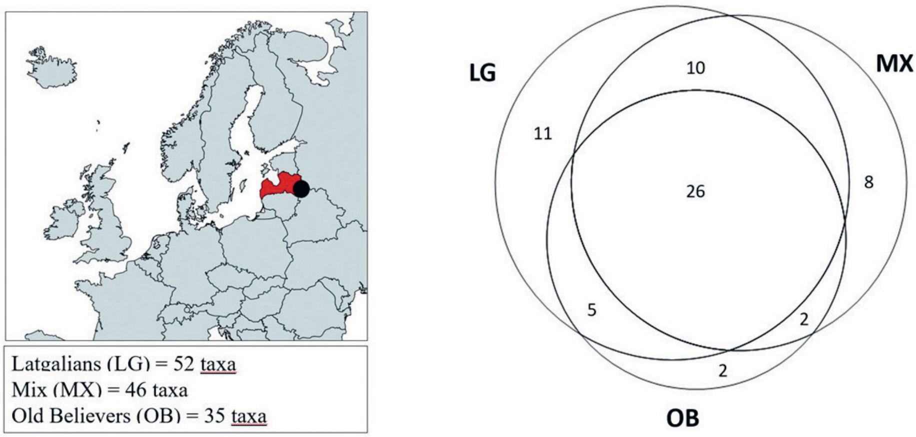



**Figure 6.** Overlap of currently used food taxa among Latgalians, Old-believers and mixed group. Modified from Paper III

As for the medicinal plants, the religious standpoint stood out as the trigger affecting the usage of plants (Paper IV, Figure 7).

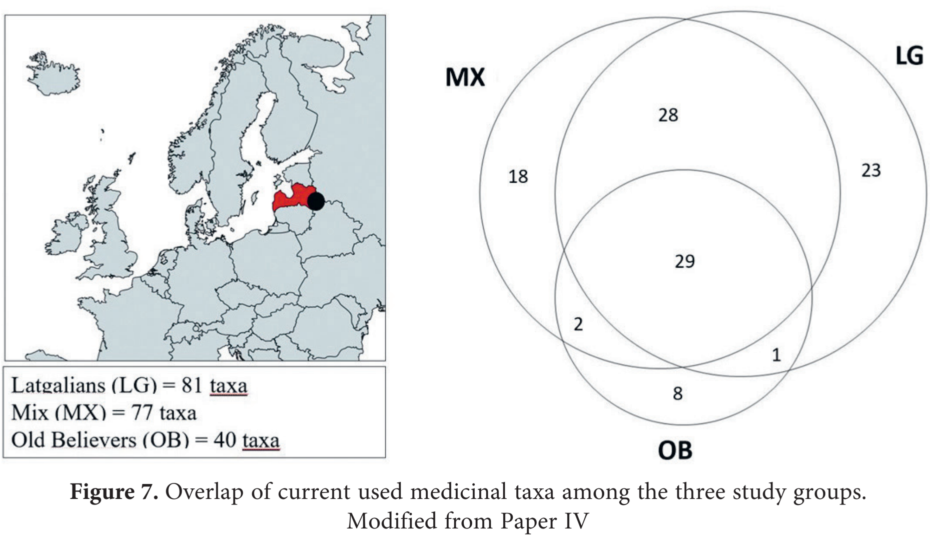



**Figure 7.** Overlap of current used medicinal taxa among the three study groups. Modified from Paper IV

With that said, the group of Old Believers characterised as self-isolated societies used the least number of taxa with little diversity of uses (Paper IV, Figure 7). In respect to disease categories, Old Believers did not report any plant use against male genital, blood, urological or neurological related diseases. However, male- and female associated illnesses are sensitive subject to discuss openly. It is relevant to add the importance of religion to Old Believers life and their faith in God (Polek, 1900). While comparing the groups, Latgalian interviewees provided a higher number of taxa for most of the illnesses. Results also revealed that Latgalian group noted less specific application of plant on the family level in comparison to Old Believers (Paper IV). This illustrates that the Latgalian group care to use the same plant families against numerous diseases. However, the results also indicate certain plant families who are also applied to distinct illnesses, e.g., Geraniaceae treating earache (Paper IV).

##### *3.1.3.1. The link of main findings to co-creating knowledge*

The *co-creation* of knowledge through ethnobotanical data is very direct from the researcher perspective as the information would not have been possible to obtain without the involvement of community members. However, this concept does not stop there. As noted above, the narratives expressed provides the research with additional insights into the reasoning behind certain changes. Additionally, the knowledge exchange with the researchers may provide new prospects for the local economy, e.g., proposals from the researchers to the community regarding the potential of introducing a small market of wild edible plants.

##### *3.1.3.2. The link of main findings to environmental science and sustainable development*

Ethnobotanical fieldwork brings numerous narratives which not only move the discipline through various hypothesis but also touch the researcher on various levels and in some instances out of academic scope. The stories regarding starvation, limited access to sugar or yeast and no other alternatives as grass for rubbing the skin for cleaning are yet fresh memories from people living in the 21st century in highly literal society. On top of that – the lines regarding the disappearance of certain taxa while for years, the environmental laws are in place bring the author to question the existing process on human and nature co-existence. Does the adaptation to the changes caused by the destruction take place for local communities and nature? Does the practice to collect plants from the wild shall change and be lost for ever? Some narratives signal that wild plants are not being found nearby anymore, and thus there is a need to buy them from the shop or pharmacy. For some, the wild seeds taste better than the purchased ones, but for some, the active practice of using certain taxa has been terminated due to the loss of the plant collection place. The above is only a small fraction of the potential ethnobotanical study contributes to environmental science studies and moreover – sustainable development.

FAO (2005) repeatedly stress the link between human survival and local knowledge. "Local knowledge is the human capital of both the urban and rural people" (…) and "for those involved in research and development processes, with local communities, it is important to see local knowledge as one component within a more complex innovation system" (ibid., p. 9, p. 11). FAO (2005) lists several sectors where local knowledge plays a great part: (1) agriculture, e.g., timing for working with the land, (2) animal husbandry and ethnic veterinary medicine, e.g., plant uses in against illnesses, (3) management of natural resources, e.g., sustainable use of wild plants, (4) health care, e.g., plant uses as a remedy, (5) community development, e.g. through sharing of knowledge and (6) poverty alleviation, e.g., survival. However, despite the contributions and possible benefits, “Locally diverse food production systems are under threat and, with them, the accompanying local” (ibid., p. 5).

Not being blinded by the current situation worldwide the author of the thesis would also like to reflect on the recent viewpoints set by several ethnobiologists which stress that: “we need to design studies that consider and prioritize economic returns to the countryside, which, as a result, may help reverse migration caused by economic problems. In particular, the development of cooperatives and other sustainable local food movements can be supported (…)” (Vandebroek et al., 2020).

As identified above, ethnobotanical data goes beyond uses of plants – therefore, the following section will provide the reader with the added value of ethnobotanical research and the importance of emic perspective.

#### 3.1.4. The importance of common natural resources (Paper V)

The application of ethnobotanical data to the question of natural resource management resulted in great success. The main result presented in Paper V provided insight into high community dependency on taxa which prefer and need human interaction, namely apophytes and anthropophytes (Paper V, Figure 8).

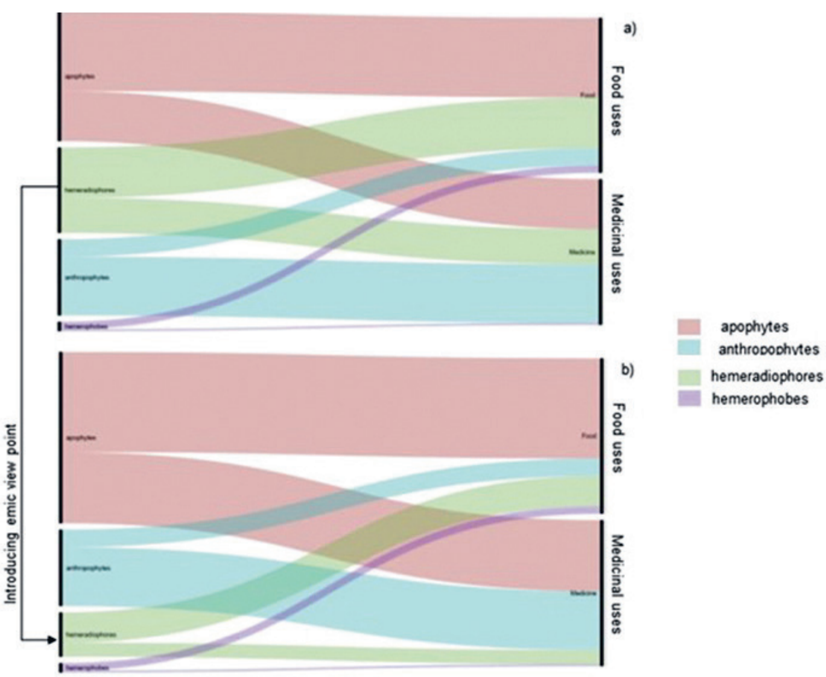



**Figure 8.** Medicinal and food use based on DUR for each taxa category. a) Based on Kukk (1999) division; b) author modification, including emic viewpoints. Modified from Paper V

This study employs the use of Kukk (1999) definition, namely, anthropophytes depend on human activity, whereas apophytes – prefer human activity. Figure 8 also represents hemeradiophores which can grow either in human-disturbed and untouched habitats and hemerophobes – preferring no human disturbance. Laiviņš & Zundāne (1989) defines Latvian flora following similar terminology, however lacks the categories of hemeradiophores and hemerophobes.

Additionally, the results also indicated the need to analyse each taxon separately and with close attention to the **emic viewpoint** (Paper V, Figure 8). As for example, there appears to be the difference while discussing plant sensitivity to human impact if categories are driven from an etic perspective only without integrating emic categories (ibid.).

The study adds that this, in turn, gave ground for discussion as apophyte and anthropophyte taxa lack management schemes since most of the taxa under these categories are widely distributed and rarely hold any special protection status (ibid., Figure 9).

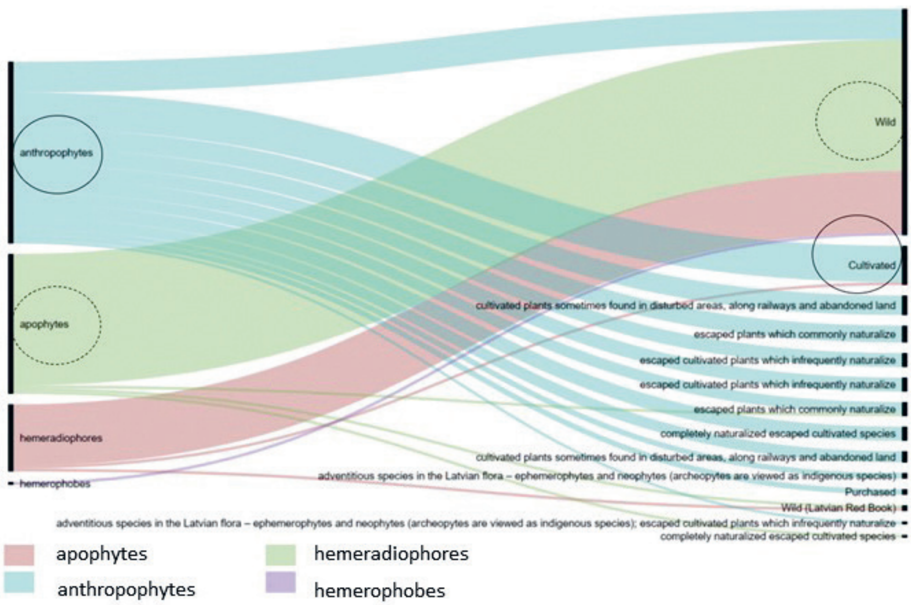



**Figure 9.** The division of taxa categories by status in the environment (authors notes & Gavrilova & Šulcs, 1999) based on the number of taxa. Modified from Paper V

Additionally, the value associated to the synanthropic plants not only stop by food use and medicinal application but these taxa are also associated with cultural values (e.g., named in Folk Songs) and environmental aspects (e.g., indicator species) (ibid., Figure 10). Therefore, the value attached to so-called common species reaches far **beyond direct values**.

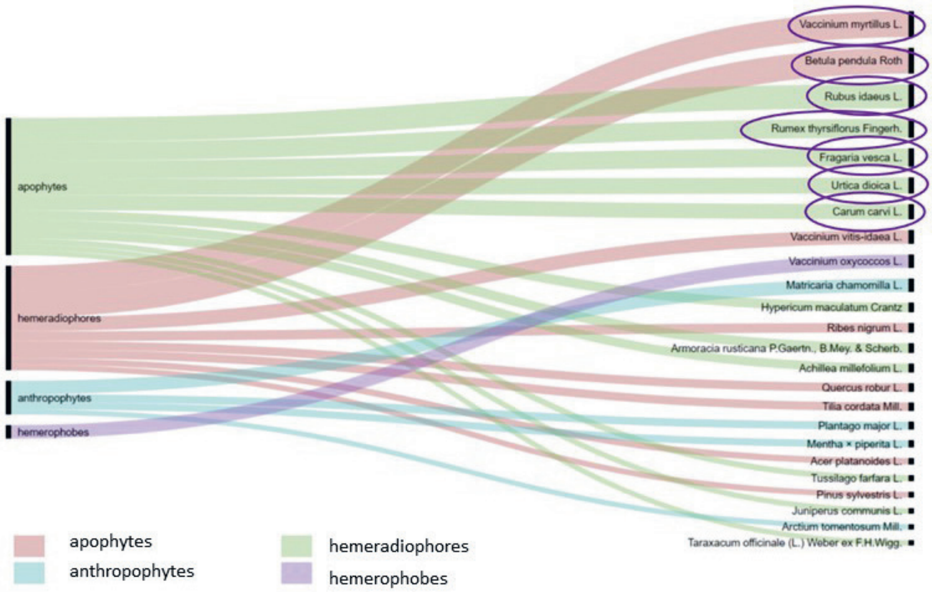



**Figure 10.** The division of taxa categories (Kukk, 1999) based on DUR > 20 among all taxa. Modified from Paper V

To note some, *Fragaria vesca, Rubus idaeus, Rumex spp.,* and *Carum carvi* under apophyte category are named in Latvian Folk Song collections and Latvian beliefs, e.g., collection of Pēteris Šmits 1940–1941 (Sile et al., 2020). As for example, *Urtica* spp. and *Carum carvi* holds a historical root in the Latvian territory (Brown et al., 2017; Suomela, Vajanto, & Räisänen, 2018). Caraway, as a food plant dates back in the 14ths century (Brown et al., 2017) and has been identified as symbolizing Latgalian identity (Svilāns, Roze, & Lukaševičs, 2012). The collection of Latvian Folk songs and beliefs reflect on various applications of *Urtica* spp. e.g., including reflection on human life, as a beauty treatment for hairs (AILab, n.d.; Dainu skapis, n.d.; Sile et al., 2020). A throughout description of the results are found in Paper V.

#### *3.1.4.1. The link of main findings to co-creating knowledge*

The author of the thesis would like to introduce to the reader the reason why this particular outcome serves as an exemplary case of *co-creating* knowledge. First of all, the resulting outcome is co-produced by **combining** local community knowledge through ethnobotany and environmental sciences through the characteristics of wild plant distribution and categorization based on plant sensitivity to human impact beyond the physical distance. Secondly, the possibility for the researcher to question existing conservation activities were only possible by **introducing the human perspective**, namely by understanding the existing practices of the local community in respect to plant uses as medicine and nutrition. Thirdly, the combination of **emic viewpoint** is a key aspect for co-creating holistic understanding of the natural resource. Numerous scholars (Norström et al., 2020;

Raven, 2019; Rodrigues et al., 2020) attach great importance of co-production of knowledge even though it might be challenging in some parts.

#### *3.1.4.2. The link of main findings to environmental science and sustainable development*

The results indicated a high dependency from the local community on common species which are widely distributed across the country. This type of phenomena goes in line with the study of Signorini et al. (2009). However, as stressed in Paper V – we must take care of these widely distributed taxa before they become rare as these taxa undergo the same pressure linked with loss of biodiversity (e.g., Gaston, 2010). As noted in Paper V (p. 13): "the perception of common might be dangerous, especially in situations where profit from the wild collection is involved (see, for example, Sheldon, Balick, Laird, & Milne, 1997, p. 8)." The study provides a ground to stress the importance to include ethnobotanical data when discussing the importance of species. For example, academic studies (e.g., Kala, 2010) provide cases where use-value of species as well as other aspects as a mode of harvest are considered while prioritizing the conservation moves and strategies.

The following and final section of this chapter will reflect on knowledge production through time (history and nowadays) and space (across Post-Soviet countries) deepening our understanding of how knowledge is built through time.

### 3.1.5. The various applications of ethnobotanical data – the search for answers (Paper VI and VII)

The study results of ethnobotanical data among seven countries at the Eastern part of Europe revealed an increase in the medicinal use of *Epilobium angustifolium* L. particularly in treating "man's problems" (prostatic hyperplasia) (Paper IV). By throughout analysis of historical sources, the results suggest that the increased use of *E. angustifolium* as treating prostatic hyperplasia might be driven from the literature and possible the treatment originally has been introduced by mistake due to repeated misinterpretation of historical (original) notes (ibid.).

Additionally, *E. angustifolium* was chosen to study long-term promotion strategies due to the reason that the taxa in interest were highly promoted as food and tea plant since the second half of 18ths century in North and Eastern Europe even though it had no cultural importance associated back then (Paper VII). The analysis revealed that most of the historical attempts to introduce *E. angustifolium* as part of diet have not gain long-lasting success (ibid.). The current uses are more associated with recent promotions through the means of online sources, to name some (ibid.). To add, the analysis also emphasised the misleading information where scholars might not have differentiated whose knowledge is reflected in the literature of interest, e.g., recommendations or documented local uses (ibid.). The in-depth analysis with numerous reflections of historical materials is presented in Paper VI and VII.

#### *3.1.5.1. The link of main findings to co-creating knowledge*

The studies provide a **critical reflection** on knowledge production. The identification of authorship of knowledge is crucial, and close attention must be paid while interpreting from where and how the knowledge is built initially from. This is particularly true while working with numerous partners, including local communities.

#### *3.1.5.2. The link of main findings to environmental science and sustainable development*

The promotion of wild edibles is highly relevant while discussing food security. The role of mediator between the literature of wild food uses, and the actual users are noted in Paper VII. Although mediating the plant use is essential while discussing the medicinal application, it holds an important aspect in certain periods, e.g., hardship (Paper VII). As noted in the study, the author of the thesis would like to emphasise the need to pay close attention to how people accept new or re-introduce new things. This might, in turn, provide us with an understanding of the possible blocks of accepting and applying the introduced uses in everyday practice. In this respect, it is relevant to note that 90% of the diet of world population depend on around 30 plant species – which as noted by FAO "feed the world" (more: FAO, 1997). A recent study by Jacobsen et al. (2015, p. 1218) summarises that "over the past few 50 years, 6 species cover 50 % of the arable land: wheat (*Triticum aestivum* L.), soybean, maize, rice (*Oryza sativa* L.), barley (*Hordeum vulgare* L.) and rapeseed." Needless to add, that "around 10,000 plant species have been used for human food since the origin of agriculture." In this respect, the mission for understanding the promotion of specific taxa is ambitious but of high relevance in these times in particular.

# 4. CHAPTER

## 4.1. CONCLUSIONS

The final chapter will sum up the main conclusions from the studies with respect to the thesis aim and provide the recommendations for hands-on activities with a focus on Latvia.

***How does citizen science and ethnobotany address co-creation of knowledge?***

As identified, for both citizen science and ethnobotany activities people voice from ground level are the core aspect of the process. And in order to be able to identify these people, stakeholder mapping may play as a supporting tool during the activities in interest. Various forms of citizen science and ethnobotany provide a ground to choose the strategies based on the research needs. However, the author of the thesis work encourages to employ the tactics where local communities are not only the data "gatherers" or the "subject" of the research but involved in investigating the issue in interest.

***How does co-creation of knowledge through citizen science and ethnobotany support SDGs?***

Citizen science and ethnobotany – go beyond data or information as both disciplines may change people lives for better. Ethnobotany in particularly provides ground for understanding plant and human relationship. And as identified in Paper III and IV the knowledge on plant uses held by local communities in Latgale supports the livelihood rather than being only a recreational activity. To add, human dimensions particularly from social science and humanities as noted in Paper I hold a high potential for citizen science activities yet are underutilized resources. To add, Paper V stress that local community knowledge provides a crucial viewpoint for enhancing biocultural diversity, e.g., rare vs common species.

***What is the potential and under what conditions for citizen science and ethnobotany initiatives to be enhanced in Latvia?***

In respect to environmental science citizen science and ethnobotany holds a diversity of opportunities in contributing to the holistic understanding of the issue in hand, e.g., practices and knowledge as well long term observations from ethnobotanical studies, data with large geographical coverage through citizen science activities. In this respect, local community knowledge and engagement provides a possibility for re-creating the responsibility of the natural resources on the ground level. The knowledge *co-created* for SDGs through ethnobotany and citizen science involves numerous thematical areas including food security, medicinal system, environmental issues. Citizen science and ethnobotany hold high potential for Latvia for reaching SDGs. However, the author urges to recognize the benefit of integrative approach with the local communities as a prerequisite for reaching SDGs.

## 4.2. Recommendations

With the following, the author intends to provide key aspects of where citizen science and ethnobotany might be directly applicable for supporting the implementation of SDGs with focus on Latvia. Three primary documents are used as the base for the following section: Agenda 2030 (UN General Assembly, 2015), Implementation of the Sustainable Development Goals – report from Latvia (hereafter Latvian report) (Government of Latvia, 2018) and "Latvija2030" (Saeima of the Republic of Latvia, 2010).

***Food security (SDG 2)***

Latvian report (Government of Latvia, 2018) notes: "The most relevant aspects of SDG 2 for Latvia (...) are ensuring sustainable agriculture." The involvement of lay-people through ethnobotanical research may provide information on traditional, sustainable agriculture practices. See Box 9. Additionally, in territories with a shortage of baseline data, public participation through citizen science activities by observations might provide data on the change in the environment. See Box 3.

***Education and culture (SDG 4.7)***

"Latvija2030" (2010, p. 15) adds that: "Inhabitants of Latvia have a common material and non-material heritage, which has been accumulated in creative work that has lasted for centuries." Here the cooperation with local communities through ethnobotany can support the documentation of the existing practices and knowledge on the plant use. See Box 7. Additionally, citizen science approach through the involvement of pupils would provide an opportunity for creative learning. See Box 2.

***Aquatic and terrestrial ecosystems (SDG 14.a and 15.1)***

"Latvija2030" (2010, p. 94) notes that: "Disbelief and distrust of inhabitants in state administration is a reason for insufficient involvement of the society in planning, implementation and supervision processes of action policies." This is particularly relevant while discussing natural resource management strategies. Here participatory ethnobotany (Box 4) or co-created[cs] (Box 3) initiatives might become a tool for public involvement in decision-making process, providing a ground of transparency and openness.

*"Nor has science sufficient humanity, so long as the naturalist overlooks that wonderful congruity which subsists between man and the world"*
*(Ralph Waldo Emerson, 1836, p. 84).*

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# APPENDICES

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