



Eurolithos case study

Connecting stone in constructions with stone resources: a technical case study

Thematic focus: Stone in constructions

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Construction name	Construction period
Folkets hus	Post WW2
Vitenkapemuseet	Late modern
Solblden	Post WW2
E.C. Dahls	
Erkebøppegården	Medieval
Nidarosdomen	Medieval
Vår Frues kirke	Medieval
Gildevangen	Late modern
Tinghuset	Late modern
Lademoen kirke	Late modern
Sparebanken	Late modern
Lademoen park	Post WW2

Photo of construction: 
april2003 055.jpg
Description if needed: **Bankhallen (interior) finished 1923**
Stone type:
Name of stone: **Hovinsandstein**
Commodity: **Commercial sandstone**
Lithology: **Metagreywacke**
Map link: https://geo.ngu.no/kart/common_mobile/kart/mi/metalnreserse_mobile_lang=no&extent=255286.2,927457788.7005512,80081409.270553.3552453,788,7012240.57831409:map=9

Executive summary

The use of ornamental stone in architecture “as it is” makes it unique compared to other geological resources. Thus, the connection between constructions and the resources is a crucial part of the resources’ intrinsic value. This case study aims at exploring possibilities for making such links, not just by exploring and describing constructions, but also by creating a digital registration and interpretation system. The city of Trondheim, Norway has been used as a case study area. By defining key features to be included in such a survey, and thereafter exploring applications and tools that can provide the needs, the case study concludes by recommending a tool based on ArcGIS survey123. A version 1.0 of registration and analysing application has been made and will be made available to the GeoERA community.

Keywords

Ornamental stone, dimension stone, constructions, buildings, use of stone,

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Introduction

The use of ornamental stone in architecture “as it is” makes it unique compared to other geological resources. Thus, the connection between constructions and the resources is a crucial part of the resources’ intrinsic value.

This case study aims at exploring possibilities for making such links, not just by exploring and describing constructions, but also by creating a digital registration and interpretation system. The city of Trondheim, Norway, has been used as a case study area.

Some conditions for the study were drawn:

- One construction can include many stone types; thus, there is need for “one-to-many” relations in the system.
- We want to include different types of use for each stone, i.e. façade, floor. This means the need for registration of many types of uses for each stone employed.
- We wanted easy solutions for uploading pictures “as we go”.
- No borders: no restrictions for where one can use the application – i.e. that a Norwegian stone used in Shanghai easily can be registered together with national uses.

Stakeholder activities in the case study included discussions about what features to include, aiming at balancing easy registration with need for information. Regarding the latter, we have tried to stick with information that is not easily achieved from other open information sources.

Methods applied

First phase: defining information to be included

Construction: rough characterization of different types, i.e. building, street, monument. In addition, the period of construction (Table 1). In addition, text fields such as name, construction year and description, should be included. Geographical coordinates are also needed.

Table 1. Codelists for construction type and construction period, the latter with explanation

Construction type	Period	Period explanation
Building	Pre-history	Before written history. The ending varies from place to place from 5000 years ago until recent.
Square	Antiquity	Between pre-history and the Middle Ages (Medieval period)
Road	Medieval	From the fall of the Roman Empire to the Renaissance
Bridge	Early modern	From the Middle Ages to c. 1820
wall	Late modern	From c. 1840 to WW2
Monument	Post WW2	After 1945
Sculpture		

Each stone type should be roughly characterized by its unique name, commodity type (Table 2) and lithology. In addition, there should be place for map link (i.e. google maps or other) and link to more information about the stone. Finally, information about how the stone is used in the construction (Table 2).

Table 2. Codelists for commodity and place of use in construction

Commodity (INSPIRE)	Place of use
Commercial granite	Facade
Commercial basalt	Base
Commercial marble	Columns
Commercial sandstone	Ornaments
Commercial greenstone	Frames
Commercial limestone	Cornice
Commercial slate	Roof
Miscellaneous dimension stones	Paving
	Interior wall
	Interior floor
	Monument
	Sculpture

Second phase: defining conditions of use

The ideal solution would be simple to make, simple to use, can be used and copied by many and provide a geographical platform to study distribution patterns of stone resources. It should also be easy to use by third parties, such as national building authorities and others in need for information about a building of historic interest in need for restoration. Thus, it should be easy to publish to professional users.

The collected data will be valuable also in the future. Thus, secure storage is needed preferably with logs of new data entries.

Choice of solution

At an early stage, several systems and applications were evaluated (Table 3). The following issues were important in the evaluation:

- Easy to use
- Secure storage
- Export possibilities/analytical tools
- One-to-many relations possible

Table 3. Overview of solutions/software evaluated and result of the evaluation

Solution	Strength	Weakness	Result
<u>Qfield (QGis)</u>	Open, free	Complex relations not possible	Discharged
<u>MS Access</u>	Complex relations possible	geographic interface weak/difficult	Discharged
<u>Open Streetmap</u> /Wiki	Open, free, Complex relations possible	Tracking and logging difficult, not possible to control changes and storage	Discharged
<u>ArcGIS collector</u>	Flexible for registration of polygons and points	Difficult to use without basic GIS knowledge, Complex relations possible, but difficult in use	Discharged
<u>ArcGIS fieldmap</u>	Flexible for registration of polygons and points	Difficult to use without basic GIS knowledge, Complex relations possible, but difficult in use; still new, more testing of opportunities needed	Discharged
<u>ArcGIS Survey123</u>	Easy to use	Complex relations not possible for registration Choose either points or polygons	Discharged
<u>ArcGIS Survey123 connect</u>	Easy to use, complex relations possible, good publishing possibilities	Choose either points or polygons	Selected

Survey123 Connect was selected mainly due to its easy ability to serve the one-to-many relations (i.e. many stone types in one construction). In the future, there will probably be similar tools also available in the open source community, but so far there is not. However, many institutions working with spatial data (i.e. geological surveys) have Esri-license including ArcGIS online, which will enable them to use the application.

Structure, data and connections

ArcGIS Survey123 (the basic version) is web-based, so there is no need for software download. However, for getting access to the more complex solutions (such as one-to-many relations) a special version that needs downloading and installation is needed – ArcGIS Survey123 Connect. This application operates in interface with MS Excel, where excel sheets define “programming” (Figure 1) and codelists (Figure 2). For instance, creating an option of adding an infinite number of stone types to a building, requires a code in excel defining beginning and end of the feature group that can be repeated many times (“begin repeat” and “end repeat” in Figure 1).

Survey123 application “Stone in constructions” if the rights are distributed to you or you have it ready on your ArcGIS online account. Click on the icon and you can start (Figure 3).

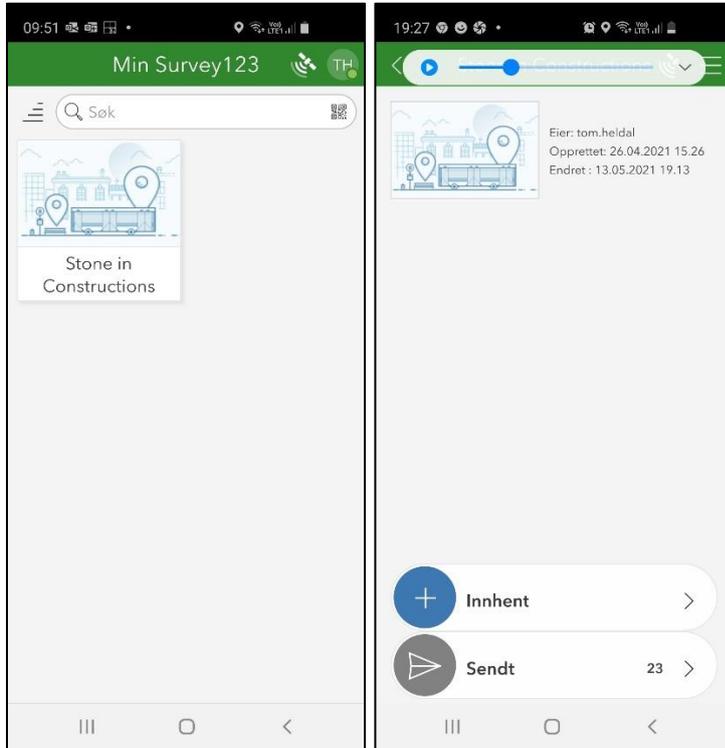


Figure 3. When logged in, click the icon of the survey. Next, you may add new registrations (“innhent” in the figure) or view your previous ones (“sendt”).

Next step is to register a construction. You fill in the form, provide the map location and take or upload photos needed (Figure 4, Figure 5).

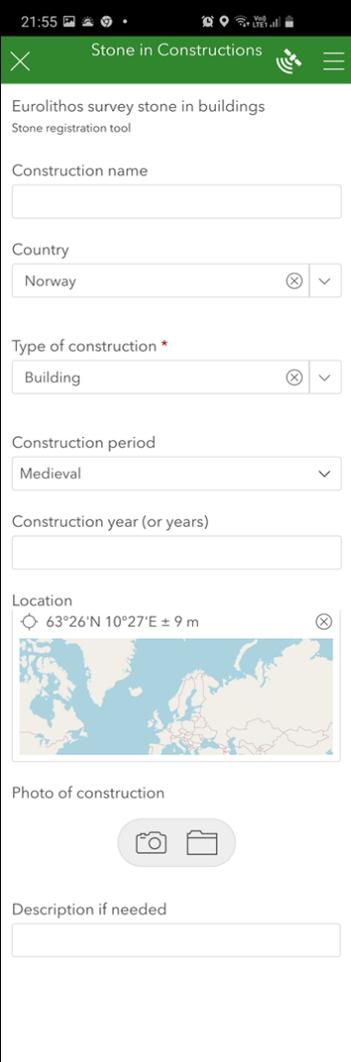
	<p>Name of construction (free text)</p> <p>Country (mandatory)</p> <p>Type of construction (one-choice list, mandatory)</p> <p>Construction period (one-choice list)</p> <p>Construction year (free text)</p> <p>Map (see below)</p> <p>Photo of construction (take on site or upload from file)</p> <p>Description (free text)</p>
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Figure 4. How to register a construction with geographical location

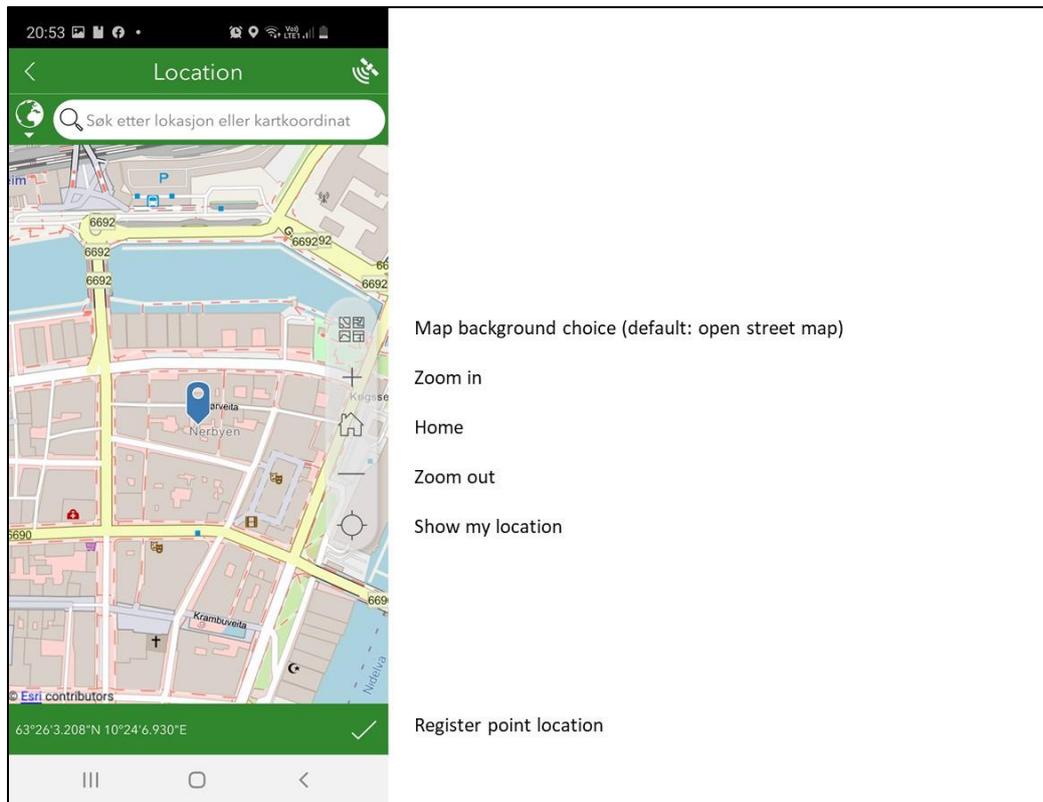


Figure 5. How to register location from map provided

Next, you fill in the form for the first stone type in the construction, that you want to register. You fill in the form, take or upload photos (Figure 6), and move on to the next stone type.

Please use the Eurolithos vocabulary: For commodity, use the terms having “dimension stone” as “parent” (such as Commercial granite, Commercial slate”). For “Lithology”, use the terms given in each of the “Commercial” groups (such as monzonite, rhyolite, etc.). See vocabulary [here](#).

In “Map link” it is possible to give the most useful link to a point or to an area on a map, either your national database, EGDI or google maps.

In “fact link”, you may use any fact sheet, but clearly link to uploaded EuroLithos directory sheets is a natural selection.

Photo of the particular stone in the construction you may take on site or upload.

	<p>Name of stone (free text)</p> <p>Country of origin (of stone resource)</p> <p>Commodity (INSPIRE: one-choice list)</p> <p>Lithology (free text)</p> <p>Map link (google or other map links)</p> <p>Fact link (directory or other fact sheet)</p> <p>Photo (take on site or upload from file)</p> <p>Use (multiple-choice list)</p> <p>+ add new stone type</p>
<p>✓</p>	<p>Finish registration</p>

Figure 6. Form for stone type

When you have finished registration of all stone types, you click on the ✓ for ending the session. You will now be asked if you want to send, abort or save for later sending (Figure 7).

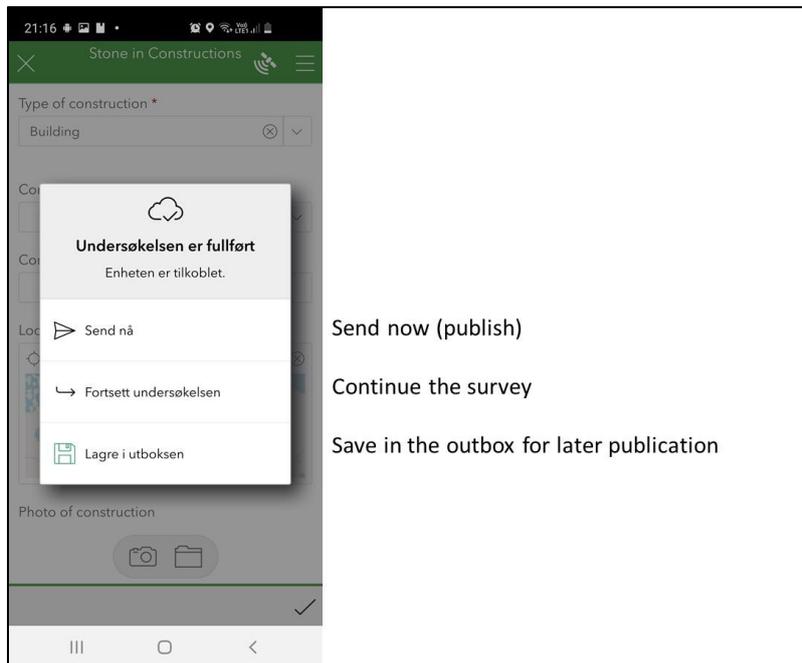


Figure 7. Ending the session

Editing and analysing data

When accessing the data by logging into ArcGIS survey123, it is possible to edit and analyse them.

First, you will get an overview of data entries (Figure 8).

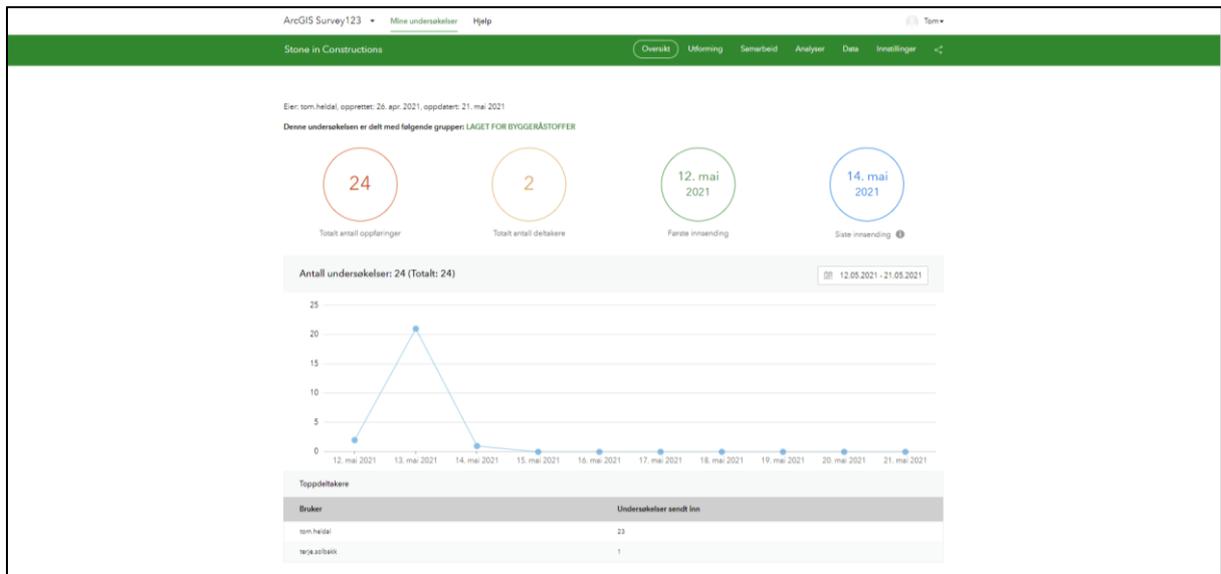


Figure 8. Overview of number of entries, number of people making the entries and dates for first and last entry

If entering “data” tab, you can view the registrations of constructions. You can also edit the data by entering editing mode.

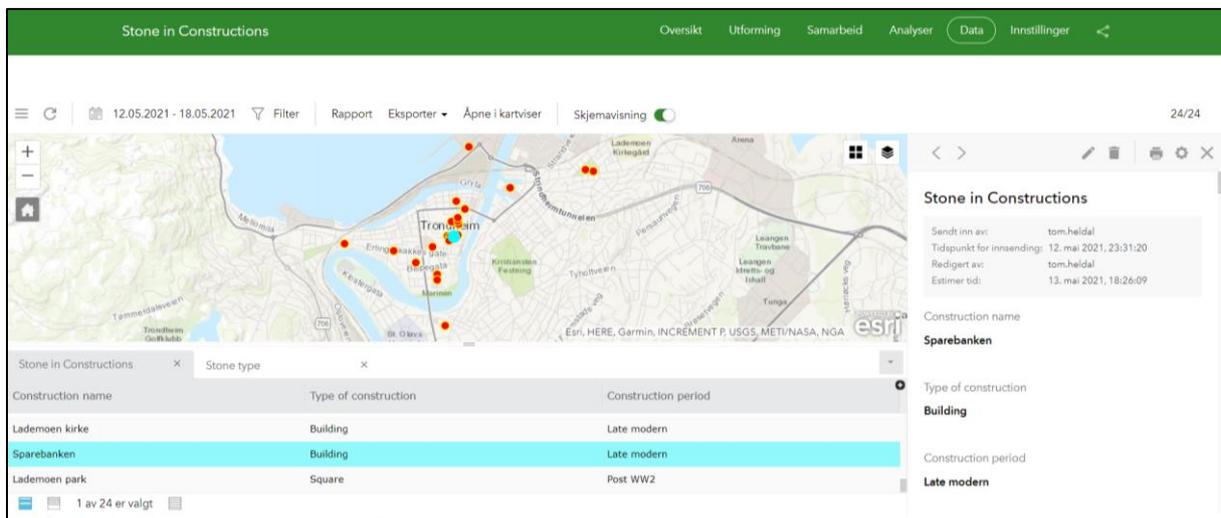


Figure 9. Map view and individual view of entries. Here you can enter editing mode

By viewing tab “stone type” you can view all the stone types employed in your survey.

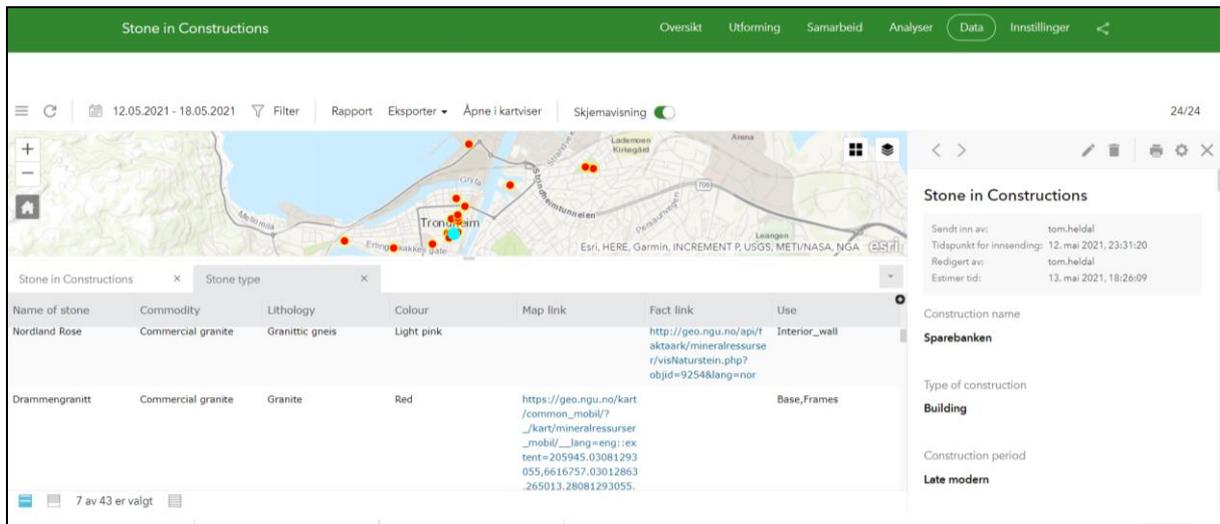


Figure 10. Stone type tab

The tab «analyses» give you access to statistical, pre-defined analytical tools, such as distribution of construction types, stone types employed, etc. (Figure 11, Figure 12, Figure 13). It is also possible to display photos or other information for viewing (Figure 14).

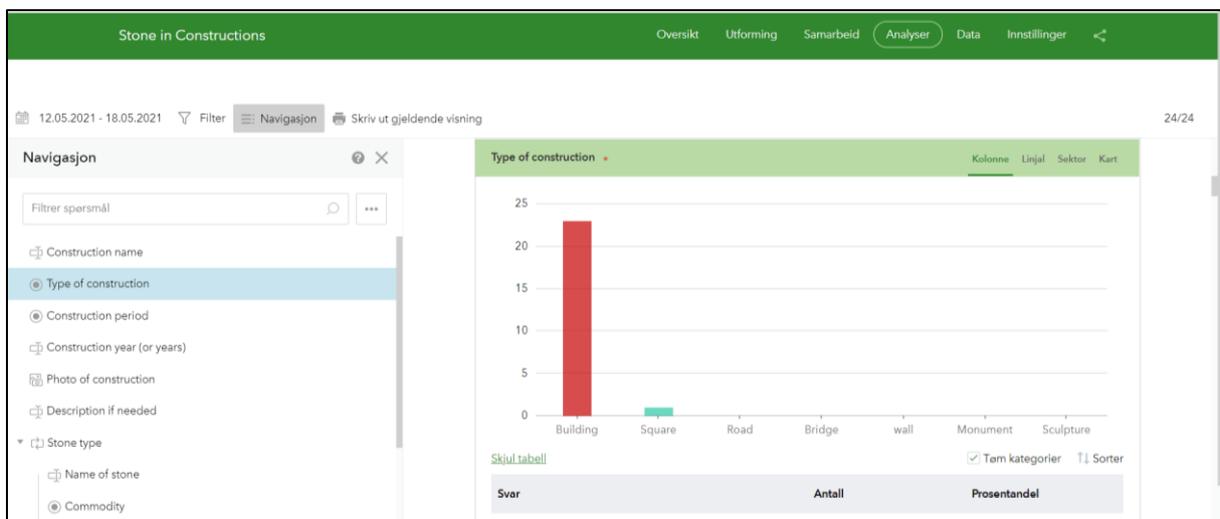


Figure 11. Analysing: type of construction

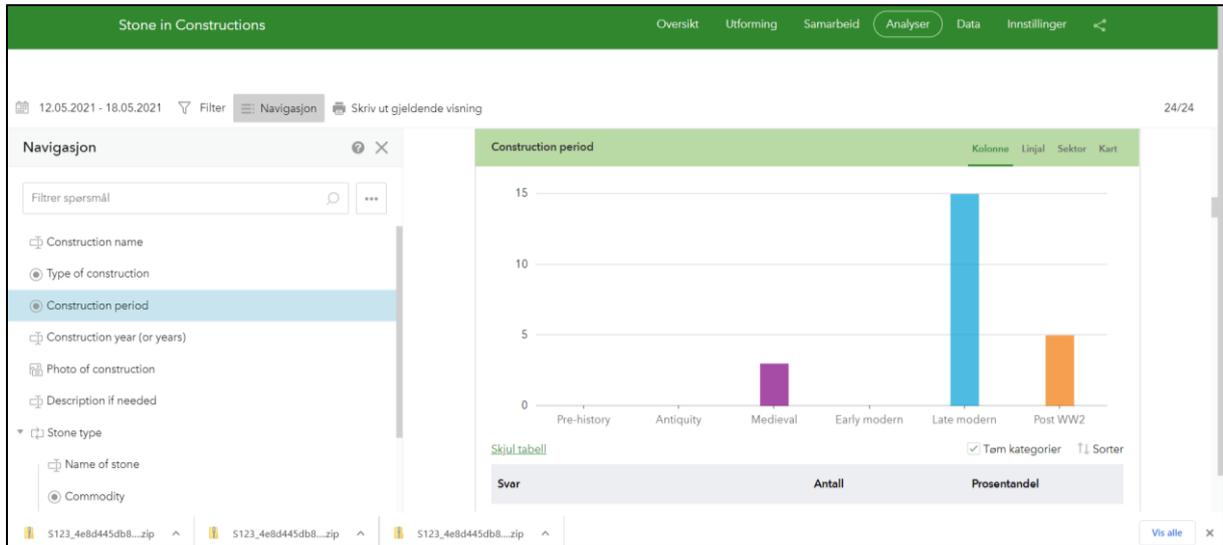


Figure 12. Analysing: construction period

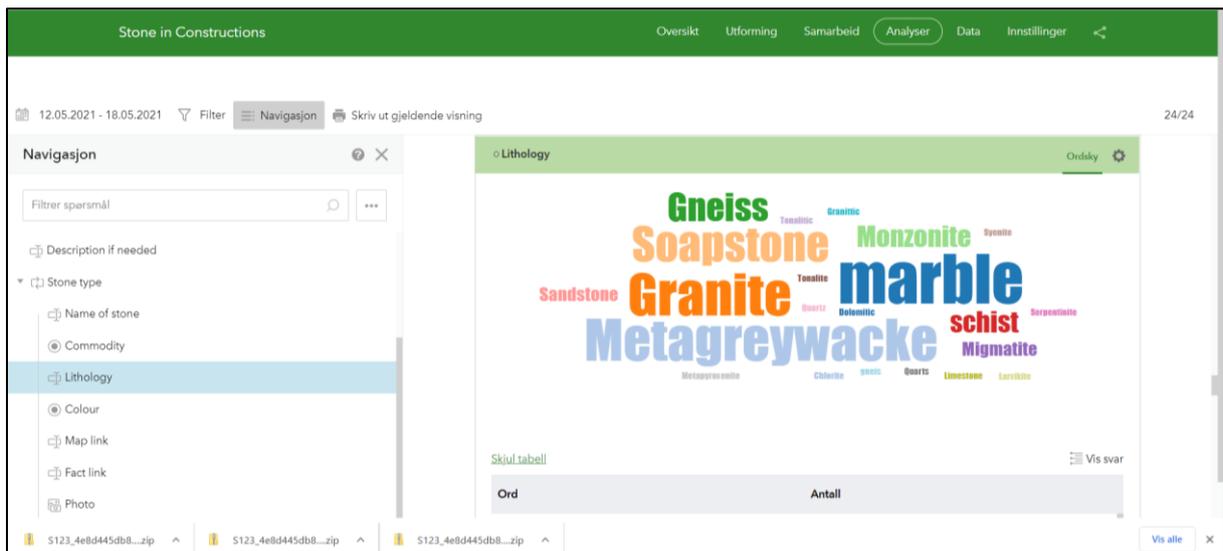


Figure 13. Analysing: commonly used lithologies, word cloud style

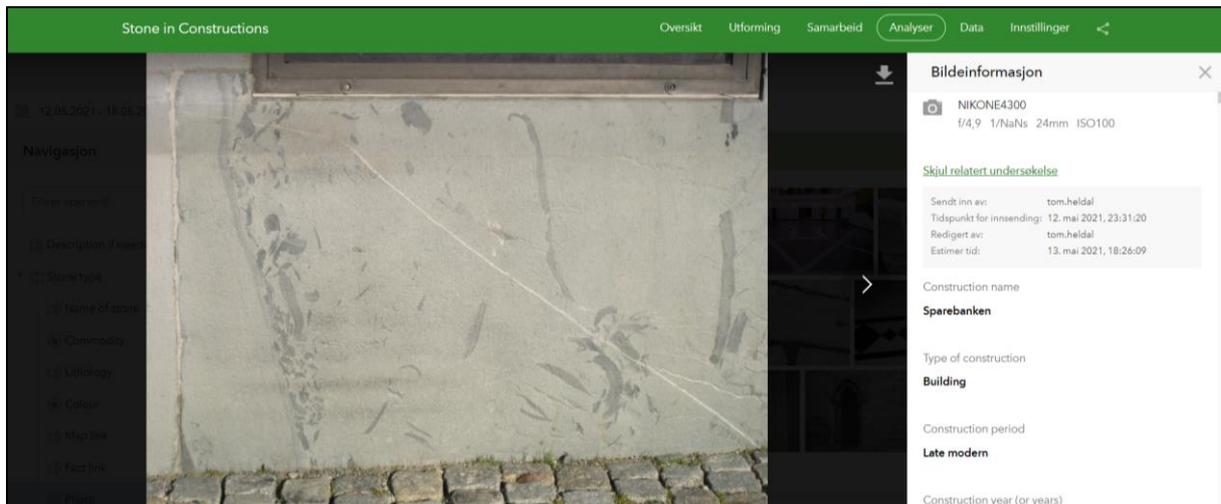


Figure 14. Displaying: photo of stone type in part of construction

The next step – exporting data to other applications

At regular intervals, one may want to export the collected data to other formats (Figure 15). There is an export tab, where you may decide to export to csv, excel, shape or geodatabase formats. Geodatabase is the only format that can maintain the complex structure of the original data. When opening in ArcMap or ArcGIS pro, you may explore different ways of visualising the data. For example, by joining the Survey table with the Stone type table, you may display the use of particular stone types on a geographical scale.

When all the data is stored in a geodatabase, it is easy to store the data intact and for future need, given that your data forms a part of a geoscience data infrastructure, nationally or internationally.

It is also possible to publish on an ArcGIS online platform, to be shared by everyone with access to that.

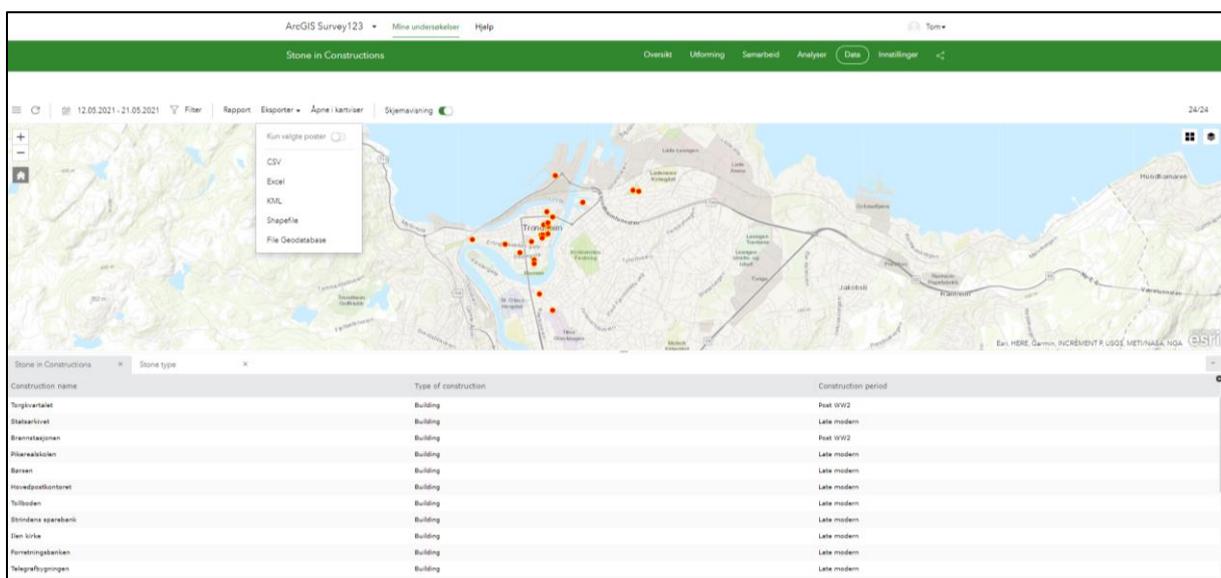


Figure 15. Export options

Publishing this survey

There are several ways to make such a survey active:

- 1) Make it public, available to everyone. This will make everyone capable of using the ArcGIS survey 123 on their mobile or other hardware and register new data. However, the user will be anonymous and cannot view the end results without this being published by the administrator. The administrator thus cannot see if the contributions are Of high quality or not.
- 2) Invite individuals with access (mostly through their employer) to ArcGIS online account. All contributors can be identified, and all users/contributors can access analytical tools and edit their own data.
- 3) Make the coding and setup for surveys available to those who want to use the app for their national survey.

Here, there are no absolute answers. However, these three alternatives can be tested and evaluated.

Case study conclusions

At the present time, the ArcGis Survey123 seems to be the best option for registration, storing and displaying data about stone in constructions. To make the survey template, ArcGis Survey 123 Connect is needed. For making registrations, only ArcGis Online account is needed.

In theory, it is possible for the whole European partnership on ornamental stone to use the solution in one central survey, but it will create very large files, due to the photos. When the files are stored on ArcGIS online, credits run and this may turn out costly for the owner.

Thus, until there are open source solutions, national scale (and in some countries, regional) seems to be an appropriate, practical level. By using the same survey, export to file geodatabase, it is easy to regularly update, for example, a European distribution map for stone types in constructions. One step further could be to keep the heavy database containing images on a regional/national scale, and create a data export line for databases without such content.