

TOWARDS A SUSTAINABLE PROJECT FOR ARCHITECTURAL HERITAGE CONSERVATION IN YEMEN

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KEY WORDS: cultural heritage, close-range photogrammetry, technology transfer, sustainable cooperation

ABSTRACT:

A group of teachers and students from the ENSG (*Ecole Nationale des Sciences Géographiques*, France) first came to Yemen in October 2004 to survey the Great Mosque of Sanaa, on the point of being restored. The resulting documents convinced the Yemeni authorities that close-range photogrammetry is a relevant technique to produce reliable documentation of endangered buildings. The idea of setting up a Yemeni team for documenting the Yemeni cultural heritage was then easily agreed upon. In the framework of an agreement signed in 2007 by both parties, the ENSG and the SFD (Social Fund for Development in Yemen), the team was trained regularly by ENSG teachers to learn how to produce an accurate survey of a building with cheap equipment and user-friendly software.

This cooperation needs now to be assessed in order to guide the team towards a sustainable future. The team is quite efficient from a technical point of view; a bit less as far as organization and quality control methods are concerned. An administrative manager was recently appointed to help them in these areas, and to deal with public relations.

But the documentation team needs now to expand in order to be able to answer the increasing number of requests, one of them being the National Inventory. Inventory demands also devolved competence within the Yemeni governorates. The light recommended equipment, combined with the user-friendly software could help spread the skills, but it may be a long term process to make the people aware of their cultural heritage, since most of them see religious buildings as functional ones, rather than as a part of art or history.

Solving this basic issue is certainly beyond the scope of the current joint cooperation project; however the documentation team must start defining strict survey specification for inventory, taking into account regional features. As a complement, an ENSG student is expected to set up a GIS during the summer of 2009 where architectural surveys will be inventoried.

RÉSUMÉ:

Un groupe d'enseignants et d'étudiants de l'ENSG (*Ecole Nationale des Sciences Géographiques*, France) s'est rendu pour la première fois au Yémen en octobre 2004 pour y effectuer les relevés architecturaux de la Grande Mosquée de Sana'a, sur le point d'être restaurée. Les documents obtenus ont convaincu les autorités yéménites de l'utilité de la photogrammétrie terrestre pour produire une documentation fiable des bâtiments en danger. L'idée de monter au Yémen une équipe autonome pour documenter son patrimoine architectural a été ensuite bien accueillie. Dans le cadre d'un accord signé en 2007 par le SFD (Fonds Social de Développement au Yémen) et l'ENSG, cette équipe a été formée régulièrement par des enseignants de l'ENSG aux techniques de relevés architecturaux basées sur un équipement léger et des logiciels ergonomiques.

Cette coopération doit maintenant être évaluée pour installer l'équipe dans un projet durable. Elle est devenue techniquement efficace, avec quelques faiblesses concernant l'organisation et les contrôles. Un responsable administratif d'ailleurs été récemment nommé pour les aider.

Mais être si peu nombreux les rend fragiles. L'équipe doit impérativement grandir pour répondre à toutes les demandes, l'une d'entre elles étant le projet de mettre en place un inventaire général. Cet inventaire exige non seulement une équipe plus conséquente, mais surtout des structures délocalisées dans les gouvernorats. Le fait que les méthodes préconisées sont légères en termes de matériel et de logiciel devrait faciliter la formation de nouveaux stagiaires, mais les trouver reste un problème dans ce pays où la population n'est pas encore sensibilisée à son patrimoine.

Résoudre ce problème est au-delà du cadre de l'accord actuel, mais il faut d'ores et déjà réfléchir à des spécifications rigoureuses pour un inventaire général, en tenant compte des particularismes régionaux. Un stagiaire de l'ENSG est d'ailleurs en train de mettre en place un SIG qui rassemblera, entre autres choses, les différents relevés architecturaux.

1. INTRODUCTION

1.1 Context

Yemen has a very rich architectural heritage which needs to be transmitted to future generations. Any action of safeguarding this cultural heritage is of course valuable. The first step to preserving a monument is simply to produce a complete and precise documentation of it.

The idea of using traditional techniques of close-range photogrammetry to produce documentation of cultural heritage was first introduced in the SFD (Social Fund for Development in Yemen) in 2004, when the ENSG (*Ecole Nationale des Sciences Géographiques*, France) came to survey the great mosque of Sanaa, on the point of being restored, in order to convince the Yemeni authorities of its interest (Héno 2007).

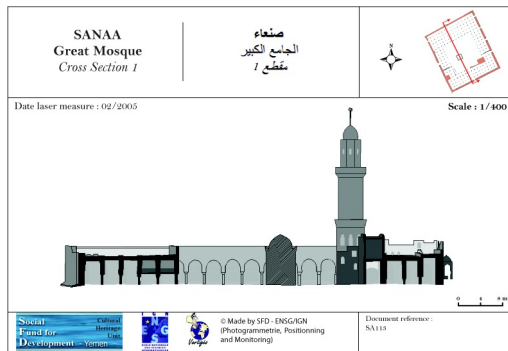


Figure 1: Example of document delivered to SFD; cross section of the Great Mosque of Sanaa

Besides proving to Yemeni authorities the validity of photogrammetric techniques, the idea was also intended to set up in Yemen, and first in SFD, a specific unit specialized in advanced documentation techniques for the historical architectural heritage of Yemen. For that purpose, ENSG teachers have identified some Yemeni experts from among various specialists (architects, surveyors, engineers) as being sensitive to the urgent need to produce complete and accurate documentation of the rich Yemeni architectural heritage and able to understand the methods to produce this documentation.

At the beginning, these people were trained intensively on the various techniques needed to produce the required documentation.

1.2 Agreement

Then, in the framework of an agreement signed in June 2007 by both parties, the ENSG and the SFD, these experts were trained regularly by ENSG teachers in Yemen and also twice in France, to learn how to produce an accurate survey of a building with cheap equipment and user-friendly software developed and provided by Y. Egels, an ENSG photogrammetry professor.

2. THE YEMENI DOCUMENTATION UNIT

2.1 Staff

The core team is mainly composed of four persons: two architects, one surveyor and one graphic designer. Most of them knew very little about close-range photogrammetry at the beginning, but regular presentations and practical training by ENSG teachers made them more at ease with the various aspects of that technique.

2.2 Advised methodology

The methodology, recommended in the Venice charter (UNESCO), implies making a fast field operation, having no direct contact with the monument, then processing the data in the office. In order to obtain a reliable and accurate survey, being faithful to the shape and appearance of a monument, topometry and photogrammetry are used altogether.

In the field, after a very careful identification phase, a network of ground control points made of targets and natural

points is built up, measured, and computed. Complete stereoscopic coverage of the scene of interest (ceilings, walls...) is shot. Both 3D computation of the ground control points and image checking are done in the field while further processing (georeferencing of the images, orthoimage computation) is done back in the office.

2.3 Software and equipment

At first sight, one may be surprised not to find any terrestrial laser scanner at the SFD's documentation unit. As a matter of fact, laser scanning has been more and more used for architectural surveys in the past ten years. The numerous advantages of that technique are regularly demonstrated in the literature, one of them being its ability to show results in real time.

However, the indisputable potential of laser data may be hard to benefit from for beginners. Since laser data is awfully cumbersome, a lot of processing is needed to provide the customers with usable products.

Besides, terrestrial laser scanners remain relatively expensive. Such an expense is not justified as long as the documentation unit has not proved itself.

Thus, ENSG teachers first recommended using relatively cheap equipment, that is to say a camera (canon EOS5D) and a total station (Leica TCR803). The office equipment simply includes technical computers, equipped with a 3D polarized screen and glasses for stereoplotting.



Figure 2: Field equipment



Figure 3: Office equipment

Most software is provided by the ENSG, and more specifically developed by Yves Egels, a photogrammetry expert. Software is easy to use, and well adapted for architectural photogrammetry. Delphi language makes translation into English or Arabic easy.

3. CURRENT STATE OF THE PRODUCTION

3.1 Possible products

Close-range photogrammetry theoretically makes the following architectural products possible: topometric ground planes, elevations (orthoimages) and cross-sections. As far as

facades and ceilings are concerned, there are two cases to consider:

- Whenever the surface to be described may be considered as a plane, even with a slight relief, the processing is a mere rectification. The production process only requires full stereoscopic photographic coverage and four ground control points well spread on the object (the rectification process uses tie points to reduce the number of needed control points)
- In other cases (cupola, dome, tower...), a 3D model of the surface, provided by manual stereoplotting, is required. The 3D model can be used as a final product, or as intermediate data to produce a true orthoimage.

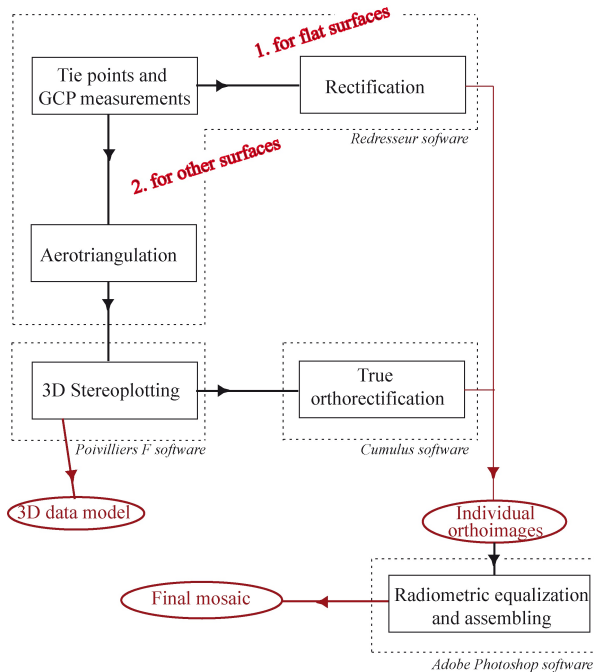


Figure 4: Orthoimage production process

Whatever the method, both kinds of orthoimages (rectified images for flat surfaces and true orthoimages for any others) advantageously replace the traditional elevations of architects. All the documentation produced by survey methods is indeed precise and unbiased: it means that it is a raw transcription of the real aspect of the monument at the time of the survey, without any personal interpretation. The documentation shows all the specificities and possible deformations of the monument.

Experience, however, shows that even geometrically accurate orthoimages may be rejected by clients, in cases of poor radiometric aspect. As an example, visible seamlines in a mosaic of orthoimages gives a false impression of the reality, discrediting the product.



Figure 5a: Correct geometry but bad radiometry leads to an unreliable product



Figure 5b: Same product with some radiometric correction

That is the reason why care must be taken to soften the big lighting differences between two neighboring photographs. Final presentation with well defined graphical rules is also important.

3.2 SFD's available documents

The list of documented architectural sites has become longer lately. Even big monuments, like the Al Shamsiah mosque in Dhamar have been surveyed by the documentation unit. The most popular documents are presently the topometric ground map and the plane rectification. Domed surfaces are still very rarely considered by the team.



Figure 6: Example of a representation produced by the documentation unit: ceilings of the Al Shamsiah mosque

4. ASSESSMENT OF THE YEMENI DOCUMENTATION UNIT

4.1 Technical level

This co-operation now needs to be assessed in order to guide the team towards a sustainable future.

The four hard workers of the documentation unit are already at ease with field techniques and data processing, even in tricky cases. This is all the more amazing because only four training sessions a year were scheduled in the first agreement. The principle was to let them work on their own in Yemen, then to check and correct their survey during the training sessions. The drawback of this high speed training is that some important points, like the organizational aspects of a survey, have been neglected. Paradoxically, the more competent they are, the more visible the organizational weaknesses are, since they survey bigger or more difficult sites.

In the second half of the agreement between the SFD and the ENSG, ENSG teachers have emphasized the importance of being rigorous, in the field and in the office. Basic rules have been regularly repeated, like: “never underestimate the pre-production stages (naming rules for the Ground Control

Points...)", "carefully document each step of the work", "properly archive data", and at last "follow through the projects to completion".

Furthermore, a long term working program should be set up, so that the team can be better organized. This long term program includes identification fieldwork, and the projects themselves (field operations, data processing).

4.2 Structural level

As long as the documentation unit is hosted by the SFD, an administrative manager is responsible for establishing the working program, and helping the unit stick to it. Keeping the schedule constantly in mind, he can arbitrate the miscellaneous requests for surveys.

5. PERSPECTIVES

5.1 Moving the documentation unit

Moving the documentation unit into another structure has been considered by both parties since the beginning. The SFD, as a bank, was financially strong enough to endorse the first steps of the team, but is expected to let it move into a more suitable place as soon as it proves itself autonomous. From a general point of view, hosting the documentation team outside the SFD should contribute to its sustainability.

5.2 National inventory

Besides preserving the endangered buildings with metric documentation, Yemeni authorities have started thinking about a systematic national inventory. As a matter of fact the inventory would not only protect the very rich Yemeni built heritage, but also promote contemporary Yemeni architecture.

The inventory will not have to record only monuments (mosques like the Great Mosque of Sanaa, old bridges like the Shahara bridge, tombs like rupestrian ones in al-Mahweet, castles like Dar al-Hajar in the neighborhood of Sanaa...), but also typical architectural styles, up to whole villages sometimes. As a matter of fact, the Venice charter states that "the concept of an historic monument embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or an historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time ».



Dar al-Hajar Castle



Shahara bridge

Since the amount of work is obviously huge, specific care must be taken to define clear specifications, as far as methodology, precision, and final output products are concerned, and also to plan the tasks. An ENSG student is currently doing his internship in Yemen to set up a GIS for

architectural heritage. Such a system could host the characteristics of each survey: location, date, type of buildings, type of survey, available documents.

Making an inventory does not necessarily imply processing the data immediately after it has been surveyed, as may be the case for specific surveys of endangered buildings. "The time lapse between the constitution of the technical archives and their use is one of the main advantages of photogrammetry" (Carbonell 1971). Well-documented photographs may be archived and processed only later, if needed. In that case, metadata (ground control points, camera, miscellaneous) must be more than ever properly described.

5.3 Previous experiences

Reliable studies calling for funding of documentation units for developing countries have been published before (Carbonell 1971). Reading them is still worthwhile keeping in mind that the modernization of equipment makes things much easier today. It is interesting to note that IGN France who used to be very active in the field of architectural projects across the world (Abou Simbel temples in Egypt, the Borobodur temple in Indonesia, the Royal Palace of Kathmandu in Nepal...) has indeed published a lot, and also tried sometimes (in Indonesia and in Nepal) to set up documentation units locally. Unfortunately, those projects failed, not for lack of financial support –equipment and training were provided at the beginning of the co-operation projects, but most probably because the local teams were rapidly left on their own, without any technical assistance.

5.4 Necessary team development

5.4.1 Spreading the skills: Whatever the documentation unit's objectives (answering the increasing number of requests for punctual surveys or making the systematic inventory), it needs to develop considerably, and also to spread into the Yemeni governorates. The agreement between the SFD and the ENSG has been recently renewed for another two year period, so that ENSG teachers keep on raising the team to a professional level and help the team to teach new trainees. The recommended light equipment, combined with the user-friendly software could help spread the skills. Experiences in the UK have showed that non-specialist volunteers can carry out substantive fieldwork and data acquisition with simple recording methods (Chandler 2007). However, in Yemen, it may be quite difficult to find a sufficient number of volunteers for such a job. As a matter of fact, Yemeni people, though proud of their country, are not all aware of their architectural heritage, since most of them see religious buildings as functional ones rather than as a part of art or history.

5.4.2 Towards massive training: Short conferences about the importance of documenting the architectural heritage have already been given in Sanaa and in Taz. A massive consciousness-raising campaign should now be organized by the SFD, assisted by the ENSG. Candidates to help document the Yemeni built-heritage would be trained by the ENSG as far as theory is concerned (e-learning courses must be considered), and trained by experienced Yemeni people for the practical aspects (fieldwork and software use). The massive training demands robust software tools, which is not yet the case since they keep on changing at the team's

request. Robust and finalized versions of the software tools will also be translated into Arabic.

In addition to that, complete theoretical training in France for a young French-speaking Yemeni student, in the ENSG for instance, is expected to start in September 2010. This course, paid for by the French government's civil cooperation project in Yemen, will provide the student with high level knowledge in photogrammetry, topometry and GIS, and also with basic concepts of heritage conservation. The idea is to integrate him within the supervisory staff when he comes back from France, and also to set up a chair in built-heritage at Sanaa's university. As a matter of fact, the ENSG's experience in Yemen shows that trainees may progress with regular practice, and above all with frequent interactions with technical experts, like the ENSG teachers, or the ENSG students who happen to do their internships within the SFD. It proves that having a permanent teaching team there, at Sanaa's university for instance, is one of the necessary conditions to make that co-operation project sustainable.

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Ecole Nationale des Sciences Geographiques
<http://www.ensg.eu/>

Acknowledgements

Marylène Barret, French archaeologist. She was the first to move heaven and earth for training a local team to the techniques of close range photogrammetry.

Social Fund for Development in Yemen