Conclusion

Astronomical Heritage in the Context of the UNESCO World Heritage Convention: Developing a Professional and Rational Approach

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General remarks

One of the declared objectives of UNESCO's Astronomy and World Heritage Initiative is to promote nominations to the World Heritage List that recognize and celebrate achievements in science. A number of different fields of human scientific endeavour might provide a satisfactory framework for exploring issues, developing methodologies, and attempting to identify principles that apply to science heritage in general. Astronomical heritage, however, has the advantage of being universal, in the sense that every human culture has a sky and 'astronomy', which we take, broadly, to mean the cultural interpretation and use of what is perceived in the heavens. In this sense, astronomy is present in all cultural contexts, from ancient to modern, and whatever their geographical location.

What are the best ways to support and encourage the inscription of the most outstanding examples of astronomical heritage onto a globally balanced World Heritage List? A pre-requisite is to develop and establish a professional and rational approach to the identification, protection and promotion of the world's most valuable astronomical heritage.

But we also need to work within the context of the World Heritage Convention as it is applied today, developing specific approaches appropriate to properties with clear significance and value in relation to science. This imposes a framework that can be summarised by the diagram in Fig. 17.1.

In the discussion that follows, an 'astronomical heritage site' is taken to be a cultural property with part (but not necessarily all) of its cultural or natural value arising because of its relationship to astronomy. As is clear from the figure, even where astronomy accounts for all of the perceived attributes of the value (as elaborated in the dossier), it is necessary to consider a range of wider cultural (or natural) issues—the broader context—when proposing a statement of outstanding universal value (OUV).

The discussion is organised into three main parts: (1) general trends and issues arising from the Thematic Study; (2) evaluating an astronomical heritage site; and (3) creating a credible dossier. A selection of the preceding thematic essays and case studies, which deliberately include a mix of sites ranging from the world-famous to the (as yet) almost unknown, will be used to illustrate the main points made.

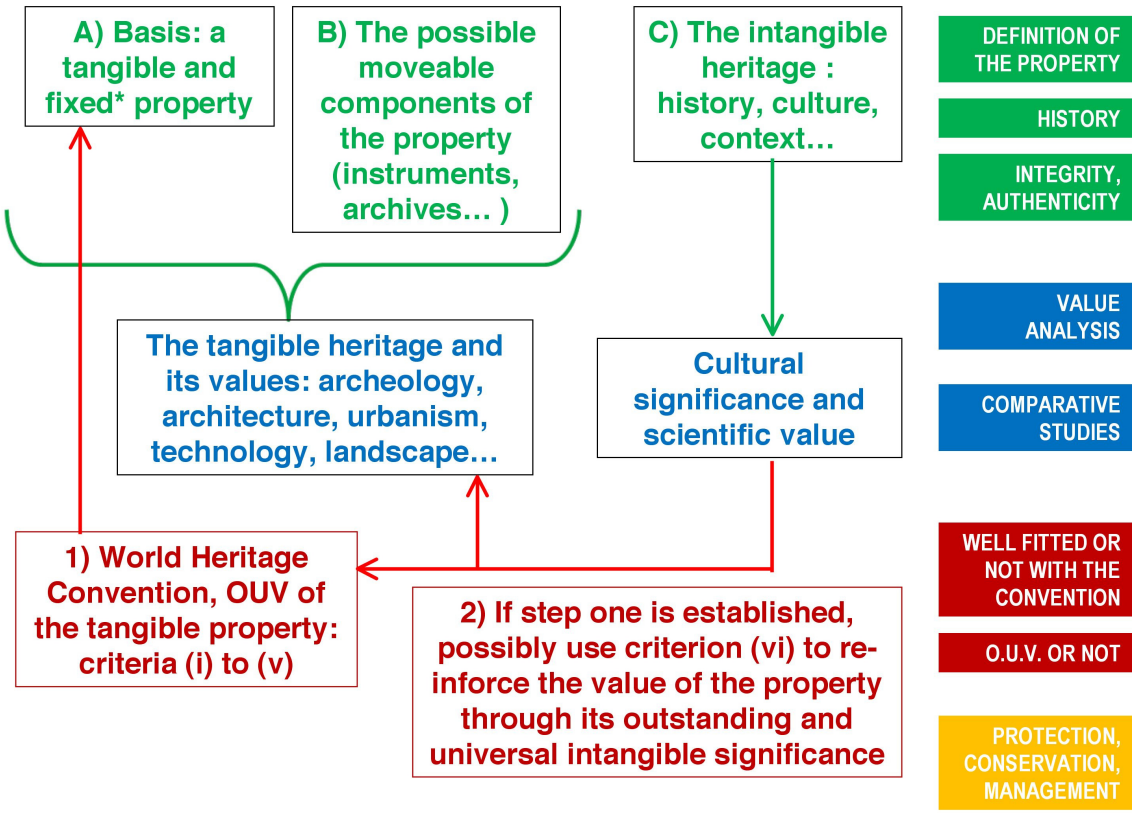

Fig. 17.1. Framework appropriate to properties with clear significance and value in relation to science. *Note that we use the term 'fixed' rather than 'immovable', since some heritage that falls under the Convention (e.g. a stone circle) is not strictly 'immovable' but is merely understood not to have moved (yet) from its original position.

General trends and issues[1]

There is no doubt that some level of interest in celestial objects and events is a feature of nearly all, if not all, human societies throughout the ages. For most of those in the past, the sky formed a prominent and immutable part of the observed world, its repeated cycles helping to regulate human activity as people strove to make sense of their world and keep their actions in harmony with the cosmos as they perceived it. In some cases this was simply in order to maintain seasonal subsistence cycles; in others it helped support dominant ideologies and complex social hierarchies. It is this quest for knowledge and understanding—'science' in its broadest sense—that most clearly links people with an active interest in the skies right through from the earliest skywatchers to modern astronomers and cosmologists. Astronomy really is a fundamental attribute of humankind, a vital facet of human culture common to every chronological period, geographical situation, and type of human society.

On the other hand, the diversity of human practices associated with observing the skies, and the variety of manifestations of astronomy in human culture, present some substantial challenges in carrying out comparative assessments of the associated heritage. One of the

[1] See also Clive Ruggles, "Astronomy and world heritage", pp. 6–15, and Michel Cotte, "Astronomical and archaeoastronomical heritage: a shared thematic study for improved understanding", pp. 81–83, in *World Heritage* no. 54 (2009), published by UNESCO, Paris.

main difficulties arises because—as the various themed essays and cases studies show very clearly—different types of heritage (as defined in the Introduction) frequently overlap. Compounded with this, the different kinds of evidence available provide different types and levels of insight into the original practices. Contrast, for example, the limitations that apply in the case of prehistoric societies, where the evidence is purely archaeological, and the relative richness and directness of the historical accounts and records that are often available in later periods. In both cases, interpretations must be based on sound theoretical principles, whether anthropological or historical, and secure methodologies. However, the firm insights that archaeological evidence can provide may often seem paltry in comparison with historical cases, with much remaining hypothetical and controversial. It must be borne in mind that such insights, although limited, may be matchless.

Astronomy in context

Beyond its manifestation as modern 'rational' science (and arguably in that case also), practices related to astronomy are inextricably linked to broader assemblages of cultural activities. It follows that the material heritage of astronomy in the form of artefacts and constructions will often be deeply integrated within material heritage of a broader nature and significance. The Viña del Cerro site in Chile (Case Study 3.4), for example, provides an excellent example of astronomy in a broader, integrated context of resource exploitation, sacred places, calendar and landscape. This implies in turn that we should not focus exclusively (or even, possibly, most of the time) upon 'astronomical heritage sites' *per se* but upon sites exhibiting an important set of valuable attributes, astronomy being just one component among others.[2]

Several sites of this nature are already on the World Heritage List, including Stonehenge (Case Study 2.1), the pyramids of Giza (Case Study 8.4), Ulugh Beg's observatory in Samarkand (Case Study 10.2), and the Royal Observatory, Greenwich (Case Study 12.1), and a challenge in these cases is to progress to a fuller recognition of their astronomical value. Where astronomy was not identified as a component of OUV, encouragement should be given for a re-nomination that acknowledges the astronomical value, and in the meantime this could at least be acknowledged at national level and included in the scope of Management Systems.

Ulugh Beg's observatory is an example of the mutual reinforcement of value coming from different cultural fields—urban, social and political history, history of architecture and decoration, cultural practices in the arts, etc.—in Central Asia during Ulugh Beg's time. The immediate urban surroundings of the Jantar Mantar in Jaipur (Case study 6.1) provide a similar example where overlapping aspects of value are gathered together in one property; similarly, the Dengfeng Observatory (Case Study 5.2) forms part of a large site including a range of 13 temples, towers, a monastery, and gardens.

Astronomy can take many forms but it is never alone: it is always a part of a larger ensemble of attributes that characterise a human society in context. Consequently, when considering the value of a property relating to astronomy, each issue should be studied taking full account of the mutual links and correlations between astronomy and other components of human culture in a given society in a given historical period. This is clearly relevant to anyone considering nominating a property relating to astronomy for inscription onto the List but it is also evident that analysis of the role of astronomy in society through the heritage already inscribed remains relatively poor and is sometimes completely absent. A real challenge exists to 're-read' and possibly 're-evaluate' many inscribed sites following the Convention rules.

The heritage of astronomy is often linked to complex systems of representation. For example, astronomical observations are frequently motivated by a need to predict the future (for various reasons including prognostication, predicting recurrent phenomena, or 'testing'

[2] An excellent example in this regard is the Einstein Tower in Potsdam (Case Study 12.5), which combines outstanding scientific and architectural qualities.

hypotheses in modern 'rational' context), and this leads to the development and use of a variety of forms of symbolic notation. As a result, attempting to interpret the heritage involves examining the diverse relationships that exist between human beings and the sky as manifested through the use of artefacts and representations. These not only include notations and drawings but also architectural constructions that 'symbolise' the skies in various ways: terrestrial material manifestations of the human cognisance of the universe that can be seen as a concretisation of the human relationship with the heavens. We must also be concerned with protocols and methods of observation, together with a full range of beliefs and modes of behaviour (i.e. magic as well as science, astrology as well as astronomy in the modern rational sense, and religious faiths as well as beliefs in physical laws).

This discussion raises once again the issue of the meaning of the term 'science', both as simple terminology and as a more complex epistemological question. In the introduction we presented, effectively, a straightforward dichotomy between modern 'rational' methods of enquiry (narrow definition of science) and any attempt to comprehend the nature of the perceived life-world by imposing some sort of cognitive structure upon it (wide definition). However, at a more subtle level the question of what constitutes 'pure science' in astronomy remains extremely open and dependent upon context. It is certainly allied to the question of predicting the future and it is also linked with cosmology (in the anthropological sense) and with religion and ideology. The general question of what constitutes 'pure' science or 'pure' astronomy is probably not relevant in itself, except in so far as it helps to define modes of connection between astronomical beliefs and practice and their social and cultural context and hence leads to more efficient ways of understanding the value of heritage sites with a relationship to astronomy.

An important category of astronomical heritage relates to the application of astronomical techniques and technology to other sciences. Thus the Struve arc (Case Study 14.1) represents astronomy as technology applied to earth science. Space science, in the sense of science carried out in space, may include astronomy but the associated fixed heritage is purely technological (Chapter 15 and see below).

Categories of cultural heritage

Several of the thematic essays demonstrate how the various categories of astronomical heritage defined in the introduction—'tangible immoveable', 'tangible moveable', and 'intangible'—relate to one another in different contexts. Although the World Heritage Convention focuses on tangible immoveable heritage (valued through intangible evidence), in our global Thematic Study we have a duty to present immovable as well as moveable, and intangible as well as tangible, since the essential evidence for certain types of early astronomy is almost exclusively in these other forms. Our knowledge of astronomy in ancient Mesopotamia, for example, comes exclusively from moveable cuneiform tablets, together with its intangible legacy in the astronomy of other cultures (Chapter 7).

In other cases, different forms of heritage may tend to relate to different aspects of the astronomy. The classic example of this is ancient Greece (Chapter 9), where the historical documents relate mainly to the development of mathematical astronomy by an elite of scholars, while much of the material astronomical heritage (e.g. the configuration of ancient temples) relates to astronomy in the service of religion practiced by the people at large. Since the first of these forms a crucial part of the history of modern scientific astronomy, the archaeoastronomical evidence is largely ignored by historians of astronomy. However, it is no less important from a cultural astronomy (anthropological) perspective. Indeed, while a classical heritage approach focused on the fixed heritage could redress the balance, it might well overemphasize the latter.

Islamic astronomy (Chapter 10) presents another balance between the availability and state of conservation of tangible fixed evidence and other forms of heritage relating to crucial developments in astronomy. Based on the available historical sources, we can create quite an

accurate account of several aspects of the development of astronomy in the Islamic world during the 12th to 16th centuries, and we know that it provided a vital link between ancient Greek astronomy and the subsequent development of scientific astronomy in renaissance Europe and in Mogul India. However, despite the huge importance of the Islamic observatories in the development of mathematical and observational astronomy during this period, none has survived intact. In other words, the fixed heritage that not only bears witness to but fundamentally underpinned these developments has largely disappeared. In this context, the partial survival of two major observatories (Maragha and Samarqand) that demonstrably played a very significant role in these developments is all the more fortunate. This must surely influence our assessment of their very high value as astronomical heritage, an importance that could come into play, for example, when facing authenticity and integrity concerns.

The balance between the various categories of legacy is an important consideration in considering the value of the tangible immoveable heritage and raises a variety of issues. For example, in the case of Palaeolithic mobile art on moveable artefacts—objects that may provide some of the earliest insights into human perceptions and uses of the skies (Case Studies 1.1–1.3):

- Does their existence strengthen the value of their place of discovery, even if they are now removed from it in museum collections?
- Should we focus at all on the place of discovery, when what is important from the astronomical heritage point of view is the object itself?
- Is the authenticity of the object more to do with the reliability of the archaeological context it came from than with its own 'genuineness' (e.g. lack of damage/restoration)?

Jumping from one end of the timescale to the other, space heritage (see Chapter 15) throws the issue of 'fixed' versus 'moveable' heritage into sharp focus. A 'fixed' location on the moon, such as Neil Armstrong's landing site or first footprint, is a moving point relative to any location on the earth; while a geostationary satellite which, to some degree of approximation, is stationary relative to any location on the earth, would not seriously be considered a 'fixed' object. Clearly, relativity of movement seems a poor criterion for heritage evaluation in these cases (albeit an excellent illustration for a major concept of modern physics). The only reasonable conclusion is that the dichotomy between 'fixed' and 'moveable' makes little sense as a classificatory criterion in astronomical heritage in particular, or in science or technology heritage in general.

Tangible and intangible heritage relating to astronomy

The 'core' heritage of astronomy as 'science' in either the broad or narrow sense—in other words, ideas, knowledge and understanding—is intangible. The essay on the historical development of radio astronomy (Chapter 13) gives an excellent example of the ways in which the tangible and intangible are inextricably interwoven in a modern context, and all of the preceding essays address this issue at some level.

The issue is also highly pertinent in the case of indigenous uses of astronomy (Chapter 4), with the example from Aboriginal Australia (Case Study 4.3) demonstrating the links that can exist in a modern context. A rather different example is provided in Chapter 4, which concerns an Ethiopian indigenous calendar of huge importance from the point of view of the anthropology of astronomy since it undermines a number of assumptions people tend to make about the 'inevitable' ways in which calendars developed in the past. However, but also raises an important question for the Convention. Surviving calendrical practices may be preservable as part of a living 'cultural landscape' such as the Cliff of Bandiagara (Land of the Dogons) World Heritage Site in Mali—but is this the appropriate way to try to sustain and protect intangible astronomical heritage of this nature?[3]

[3] Part of the traditional 'Mursi country' is in fact listed as part of the 'Lower Valley of the Omo' World Heritage Site in Ethiopia, inscribed for its palaeontological and prehistoric sites.

Despite their importance in the development of sciences and arts, the goal of the Convention is not to celebrate the achievements of individuals. Hence, as at Monkwearmouth (Case Study 11.1), the fact that a place is associated with a great person and/or their discoveries does not constitute value by itself, although it can clearly strengthen other aspects of the value.

Space heritage

Space heritage (Chapter 15) is not really heritage of astronomy but actually of science in general and of technology. Nonetheless, it is important in this study in that it raises novel questions concerning the heritage approach.

The term 'space heritage' is widely misinterpreted as the heritage of space travel, but it is really the heritage of space science, or more truly space 'techno-science'—a set of technological applications that support a variety of scientific endeavours carried out in space, of which astronomy (research) is just one. The activity of space science leaves no tangible science heritage sites on the territory of State Parties, since by definition it takes place either on other heavenly bodies (e.g. the Moon or Mars) or in space itself. Examples of the sorts of issue this raises are:

- *Ownership*. Once a satellite goes into orbit and becomes operational, does it become international property? (This invokes international law about space; there are clear parallels with maritime law.)
- *Conservation*. In the case of a dossier concerning such heritage, would a 'no conservation' policy and a Management System that endeavours 'to observe only' be acceptable? After all, there is unlikely to be any other viable option.
- *Duration of the heritage*. This is not necessarily indefinite: for example, orbiting objects in space must eventually fall back to earth.

Cultural and natural heritage relating to astronomy

The Pnyx (Case Study 9.1) is a place significant for the history of astronomy because historical records attest that it was the place from which the Greek astronomer Meton made observations of the solstice in the 5th century BC that led to his discovery of the calendrical cycle now known as the 'Metonic cycle'. There are no tangible remains, fixed or moveable, bearing direct witness to Meton's observations. However, Meton's observations may well have made use of the visible horizon (formed by a hill 3km away). In this sense, the natural landscape formed part of the 'instrument' and so directly forms part of the astronomical significance of the place (although recognising this as World Heritage could be problematic).

The same is true of the many prehistoric and historical constructions aligned, for example, on the horizon rising or setting positions of the sun (e.g. Case Studies 2.1, 2.2), the appropriate horizon point being marked in some cases by a natural feature such as a distant hill-slope or mountain summit (e.g. Case Study 4.2). It would be misleading to view most of these constructions as observing 'instruments', since that was not their main function, but it is true to say that the alignment—the feature that 'connects' the human monument to the sky and contributes to (or in some cases, constitutes the totality of our knowledge of) its significance in relation to astronomy—links the human construct and the surrounding natural landscape—doing so in an even more specific way when a horizon 'foresight' completes the alignment. It follows that the natural landscape, and in some cases specific features within it, must in a very real sense be considered as contributing to the value of the monument, implying, for example, that Management Systems would need to address to question of keeping the natural landscape intact and the sightline unobstructed. At the same time, natural sites used for astronomical purposes (both in the present and in the past, where there is clear evidence to support the assertion) could fall into the 'cultural landscape' sub-category.

A related issue is the removal of a monument, even for its own protection, as at Abu Simbel or, potentially, at Nabta Playa (see Chapter 8). If the monument contains connections with the surrounding landscape, such as alignments, then its removal may have stronger implications than simply eliminating its eligibility for inscription as immovable heritage, since such connections will be destroyed, thus also removing an important (and perhaps the only) aspect of its value as astronomical heritage and thus destroying its integrity.

Human constructions incorporating astronomical alignments are also, of course, 'connected' in a cognitive sense to the astronomical body in question: this connection was periodically 'revealed'—reaffirmed visually—when the sun, star, etc actually rose or set in the alignment. Light-and-shadow 'hierophanies' (e.g. Case Studies 9.3, 11.2) represent another case where a direct connection between a human construction and a celestial body is periodically 'made physical'. It is also true that in a more general sense all astronomical heritage sites have a connection to the very sky to which they related.

The visibility of the sky

Given that an important aspect of the heritage of many ancient and historical sites is the observation of certain naked-eye astronomical phenomena, the possibility of actually observing those phenomena today is a relevant consideration in valuing and preserving that heritage. For example, various rising phenomena of importance at the pyramids of Giza (Case Study 8.4) cannot be seen today owing to the Cairo smog (see Chapter 8), which is detrimental to the appreciation of that aspect of their significance. Since many sites relate to night-time observations, a consideration of considerable importance in this respect is the visibility of the dark night sky.

In terms of the application of the Convention, it is difficult to see how the criteria for assessing tangible cultural heritage could be extended to the sort of *negative* definition of a property (the absence of artificial light) that would characterise a 'Starlight Reserve' or 'Dark Sky Park' (Case Studies 16.1 and 16.2). Instead, we must consider this issue in terms of natural value: a dark sky is an aspect of the quality of the environment of a cultural site.

That said, in terms of scientific value (and cultural value in general) connected with the history of astronomy, it is quite valid to recognise the absence of light as a prerequisite for the satisfactory observation of the night sky.

While clearly of huge importance for astronomical observations, the darkness of the night sky is only one condition among others such as atmospheric turbulence and weather (see Table 16.0.1). The 'classical' solution to this ensemble of terrestrial problems was in effect to remove the observatory as far as possible away from them—at first by adding domes (which, incidentally, protect from rain as well as light), then to move the observatories away from cities, then up mountains, and then finally into space (see Chapter 15). The whole set of constraints/conditions that define an exceptional place for observation (see Chapter 16) itself forms an important part of the *cultural* value of the place in relation to a major observatory, particularly if that observatory plays a major role in the history of science.

The cultural value of the dark night sky extends well beyond historical and modern scientific astronomy—through its role in social history, its myths, its symbolic representations (with complex and multiple layers of meaning) and so on—across all human communities and throughout the ages. This reinforces the idea that the strong cultural significance of the dark night sky is extremely general among human societies, but also that its value in relation to a particular, well-defined cultural property can only be established with reference to a set of other remarkable attributes forming the global value (and, potentially, the OUV) of the property.

The dark sky may not always be part of the intrinsic (cultural) value of a cultural property related to astronomy but, where it is still present, it is certainly part of the intrinsic natural value of the place in question. Preserving or improving the dark sky is certainly a relevant protection/management issue in many cases. As a broader issue it rests seductively in the context of present-day ecological sensibilities.

Evaluating an astronomical heritage site

In the opening chapter we introduced a global methodology for establishing the components of a property and their significance in relation to astronomy.

In order to implement this methodology in practice it is essential to recognise an astronomical heritage site as a 'monument of science', and hence as an integrated system. This means that fundamental links are understood to exist between the following different classes of heritage:

(A) fixed heritage (monuments, sites, fixed instruments, palaeography, etc);

(B) moveable heritage (portable artefacts and instruments, archives, satellites etc); and

(C) intangible heritage (knowledge, theories, social and cultural beliefs, etc).

As a consequence, the creation of an inventory taking a global approach must take into account not only the material evidence of the property (A) but also (in relation to B and C) knowledge, outputs, applications in society, etc.

The value of fixed heritage (A), which is within the scope of the convention, together with moveable heritage (B), is critically dependent upon intangible knowledge (C). The material evidence may be modest in itself (although substantial enough to clearly demonstrate the ideas with which it is associated) but may have exceptional value as a result of the context of ideas that derives from people's understanding of the sky and celestial events. In other words, (A) derives its meaning in the light of (C), and is intrinsically linked to (C).

In order to identify our most exceptional astronomical heritage, it is important to recognise the continual interchange between the 'tangible' and 'intangible' categories, which is part of the fundamental paradigm that constitutes the scientific process in general.

We must also recognise that the history and heritage of science is inextricably linked to the history and heritage of technology. This implies that it will be at best unproductive, and at worst counterproductive, to try to classify and evaluate the heritage of science in isolation from the heritage of technology. Both dimensions certainly exist within astronomical heritage, which provides a paradigmatic example among the heritage of both science and technology. Indeed, the only tangible immovable heritage relating to space science (Chapter 15) is the technology heritage of launch sites and associated ground-based laboratories.

Integrity must be understood as the completeness of a monument of science. The question, in determining the integrity of a site and the material evidence relating to the attributes that establish its value, is whether we have enough material and intangible information to give us a comprehensive view of the property and of its historical functions.

Authenticity. The question of authenticity raises particular issues in the context of science heritage, as we have seen in the introductory chapter. Change, improvement and innovation are positive attributes of science and technology in general, and of astronomy in particular, and so are likely to add to, not detract from, the value of the associated heritage. The 1994 Nara conference on authenticity (see *Operational Guidelines*, annex 4) underlines the need for a comprehensive approach, considering the property first in its global cultural context and second in relation to a detailed description of its attributes. The scientific use of a property gives rise to a specific form of the definition of authenticity and this necessitates a careful study of each component of the value of the site, in terms of its use and associations as well as its form.

The authenticity of a 'fact' is also linked to the credibility of the 'fact' and its interpretation. In other words, it is linked to the degree to which the 'fact' has been proven according to current standards in the discipline concerned—e.g. history, archaeology or archaeoastronomy.

Serial approach. A serial approach may be appropriate but it is not an obligation. Each State Party is free to choose its own approach towards its astronomical and archaeo astronomical heritage. A serial approach would need to highlight the various similarities and

complementarities that exist between the different sites within the ensemble, as well as highlighting the different qualities that attest to the significance and value of the ensemble as a whole. On the other hand, a single outstanding example may provide a better demonstration of value, and potentially of Outstanding Universal Value (OUV) in the sense of the application of the Convention to inscribe a given property on the World Heritage List.

Credibility. The credibility of dossiers is crucial for the future of the implementation of the Astronomy and World Heritage Initiative within the framework of the World Heritage Convention. It is important not only for the World Heritage Committee but also for the scientific community in general. For this reason, we devote the main part of this concluding discussion to the topic of how to create a credible dossier for an astronomical heritage site.

Creating a credible dossier

A number of issues must be addressed in the dossier that is required for every property that is nominated for inscription to the World Heritage List. It must include:

1. a definition of the property, inventory, and definition of the buffer zone;
2. its history and its position in a global context;
3. its authenticity and integrity;
4. a comparative study with similar places in the region but also with any in other countries and, beyond that, in other epochs;
5. a value analysis;
6. protection, conservation and management; and
7. legal protection in the buffer zone.

In this section we will briefly discuss some specific issues that arise in preparing the dossier for an astronomical heritage site. For the general issues dealing with the preparation of the dossier we recommended the reader to refer to the official documents of the Convention, and in particular *The Operational Guidelines for the Implementation of the World Heritage Convention* (http://whc.unesco.org/en/guidelines/), especially annex 8. Documentation addressing specific questions can be found on the World Heritage website and on the ICOMOS website: e.g. *What is OUV? Defining the Outstanding Universal Value of Cultural World Heritage Properties* (http://www.international.icomos.org/publications/monuments_and_sites/16).

What follows is not meant to be a blueprint for a 'good dossier', but merely a first approach presenting some examples illustrating questions of methodology, the comparative study, the global survey of a period, and so on. The demonstration of Outstanding Universal Value (OUV) is a crucial objective of the dossier, and the value of the property can really only be demonstrated in relation to the global cultural and historical context.[4].

A 'bad dossier' will lead to misunderstandings and certainly fail to demonstrate OUV. Typical shortcomings in existing dossiers suggest that the main failings might be:

- weaknesses in defining the property, demonstrating the importance of the astron omical evidence, and/or showing how the astronomical significance is conveyed by the material evidence;
- weakness in the comparative study (inadequate comparisons with other potential sites);
- a flagrant overestimation of the local or regional significance of the property's attributes and/or the overemphasis of particular functions;
- an insufficient understanding of the cultural–historical context, and/or overly superficial historical studies; and
- overly controversial interpretation of the site, artefacts, etc.

[4] In some cases the comparisons need not be global but can be within a geo-cultural region.

Definition of the property, inventory, and definition of the buffer zone

Strictly speaking, 'moveable' objects as opposed to 'immovable' heritage are not covered by the Convention, as indicated into the Introduction. However they may well form an integral part of a 'monument of science'. Examples not only include observatories containing moving instruments such as modern telescopes; the observatory itself may have fixed walls but a moving dome or rising floor, as for example the McClean Building at the Royal Observatory, Cape of Good Hope (Case Study 12.2), or may have both fixed and moveable instruments integral to the design, as in the case of a radio-astronomy interferometer (see Chapter 13) comprising a fixed dish and one or more that are moveable, for example along rails. This parallels a known situation with regard to technology heritage already inscribed on the World Heritage List, examples being the Semmering Railway, Austria, the three Indian mountain railways, and the Albula-Bernina Swiss line. In all these cases the line itself (track and infrastructure) together with the stations have been recognised as of Outstanding Universal Value but the inscription does not include the rolling stock, because it is moveable. On the other hand, moveable parts of 'machines' inscribed on the World Heritage List are entirely part of the property, examples being the Transporter Bridge of Vizcaya (Spain), the locks in the Canal du Midi (France) and Rideau Canal (Canada) and the hydraulic lifts of the Canal du Centre (Belgium). Here, 'immoveable' and 'moveable' must be understood in their classic juridical sense.

From a science or technology heritage point of view, then, it is clearly essential to extend the inventory to include moveable portions where they form an integral part of the 'monument of science'. It is perhaps necessary to reemphasize that these parts perform actions, need to be maintained, and need to be replaced from time to time. Such an approach has already proved productive in technology heritage.

The example of space heritage clearly shows that there exist certain types of astronomical endeavour for which it is impossible to recognise science heritage sites on the list: only technology heritage sites. In many other cases, the heritage of the science is inseparable from the heritage of the technology, and it is natural to deal with both together in the application of the Convention.

Where features in the natural landscape form an integral part of alignments preserved in architecture, the most productive approach may be to consider two different concepts: cultural landscape heritage that should be included as part of the property, and landscape preservation that forms part of the protection of the setting. The existence of such alignments, and hence the desirability of maintaining the visible landscape in certain directions, could certainly influence the definition of a buffer zone. The definition of the setting is also of critical importance at dark-sky sites, where one needs to ensure the maintenance of the dark sky in the core area (see Chapter 16).

Serial nominations Serial nominations relate to groups of discrete sites that demonstrate outstanding universal value as a group. Within astronomical heritage sites this can arise in three distinct ways:

- where the group represents the material heritage relating to a single, integrated concept;
- where the sites in the group are linked thematically; and
- where the evidence of universal value can only be obtained by considering the group as a whole.

The 34 nodes of the Struve arc (Case Study 14.1) clearly form a group of the first type. The arc itself is a single, integrated concept. The Iberian seven-stone antas (Case Study 2.2) form a group of the third type. Each of the antas in the group was evidently built according to strict prevailing protocols, but *we* need the group as a whole in order to recognise the existence of a specific practice of astronomical orientation and hence to appreciate its significance and demonstrate its value. In this case, the definition of the property also deals clearly with the integrity concept.

A thematically linked group could relate, for example, to architectural typology, types of instrument, types of science or the nature of discoveries. Thematic linkage perhaps holds the widest potential but it also presents the greatest challenges in creating a consistent and valuable (in the sense of OUV) group while avoiding producing what is essentially no more than a catalogue of sites. To take just one example, Strasbourg Cathedral (Case Study 11.3)—which provides another starting point for reflection about astronomical heritage within existing World Heritage Sites—introduces a broader thematic context (medieval astronomical clocks) that might conceivably form the basis of a serial heritage approach, drawing out important new types of value. For this to be successful, though, each member of the group (each clock) would have to contribute effectively and significantly to OUV.

Whether OUV is best demonstrated for any particular theme through a single nomination or a serial nomination, where both possibilities are viable from the scientific point of view, requires careful consideration. Serial nomination may be more globally representative of a particular development or concept, but each element of the series must bear a significant part of the OUV by itself and so the 'weakest link' might bring it down. On the other hand, a single nomination may 'cast a shadow' on other future nominations, since its acceptance (through a comparative analysis) would imply that the one site concerned adequately characterises the OUV of the development or concept in question, and so the others are not needed.

Compromises may be possible. Serial nomination is not the only way of making connections between different sites: other options include twinning and networking between sites already on the List, on the basis of informal agreement. This has proved a successful approach in the case of Biosphere Reserves, linked through UNESCO's Man and the Biosphere Programme.

Credibility as an authenticity issue

The various themed essays and case studies raise a range of matters relating to authenticity and integrity and serve to demonstrate the complexity of the issues involved. To take just one example, the circular Zodiac, the most significant astronomical artefact in the temple of Hathor at Dandara, Egypt (see Case Study 8.3) was removed to the Louvre in Paris, where it is well preserved, and its exact original position is marked by a good-quality replica. The issues of scientific information in context, materiality of the evidence, and position of the evidence, would all be relevant to the question of authenticity in this case.

As we have already noted, the authenticity of a 'fact' is linked to its credibility, as judged by current standards in the relevant academic discipline. The issue of credibility is especially critical where the basic evidence comes from archaeoastronomy, a relatively new and in itself strongly interdisciplinary field of endeavour, where issues of theory and method are still hotly debated. Before accepting the intentionality and putative meaning(s) of astronomical alignments at archaeological, and particularly prehistoric, sites—however self-evident they might appear to the modern eye, or however stunning the associated visual hierophany—it is essential to consider the broader cultural context, balanced where possible with appropriate statistical confirmation. Chapters 2 and 3, and several of the themed essays contained within them, illustrate this point in different ways.

Nowhere are the difficulties clearer than in the oldest evidence of all, presented in chapter 1. Evidence of this type is complex. It is also inherently subjective—there are many stars in the sky and many drawings upon which one might seek to impose an astronomical interpretation—so evidence of this type and has to be weighed up with great care as well as paying sufficient attention to the cultural context.

It is helpful to identify four broad categories of archaeoastronomical credibility, examples of each of which can be found at existing World Heritage sites:

(1) *Generally accepted*. Examples include the alignment of the Neolithic passage grave at Newgrange in Ireland upon the rising sun at midwinter, and the solstitial alignment of Stonehenge in the UK (Case Study 2.1). Nonetheless, while the intentionality of these

alignments is largely undisputed, the interpretation of their purpose(s) and meaning(s) rightly continues to be debated.

(2) *Debated among specialists*. Example: the interpretation of the circular Caracol at Chichen Itza in Mexico as an observatory for watching the risings and settings of the sun, planets and stars. Archaeoastronomers continue to debate this interpretation. Despite the uncertainties, the building is widely referred to as 'the Observatory'.

(3) *Unproven*. Example: the 'equinox hierophany' at the Kukulcan pyramid, again at Chichen Itza. This phenomenon attracts many thousands of visitors each year, but there is no convincing historical or contextual evidence to support the conjecture that it was actually deliberate and intentional. Despite this, it is widely cited as the principal astronomical connection of the site.

(4) *Completely refuted*. Example: the interpretation of four rock-painted symbols at Chaco Canyon, USA as a depiction of the 1054 supernova. Cultural evidence strongly suggests that the symbols marked a sun-watching station for native priests. Yet the 'supernova' remains signposted at the site.

It is not unusual for the number of serious scholarly archaeoastronomical interpretations to be relatively small while the number of highly speculative interpretations available, both in popular publications and on the internet, is much larger—the pyramids of Giza (Case Study 8.4) are a good example. This not only has a serious affect upon public perceptions, but can also start to affect 'official' perceptions, as has occurred for example at Chichen Itza, where the Management Plan is reportedly being revised to take account of the equinox hierophany at Kukulcan.

Another factor that can sway public, and even official, opinion is the perception of certain ancient sites as demonstrating the intellectual achievements of ancestors and hence feeding modern nationalist agendas. A notorious example is the site of Odry, Poland (Case Study 2.3), used for Nazi propaganda during the 1930s. A sense of national pride or political expediency can sometimes be implicit in claims that, for example, a site is 'the oldest observatory' in a given region. The irony is that such attitudes are founded upon a mistaken belief in a single 'path of progress' towards modern science, something that actually places a negative value on other cultural perspectives and practices.

It may well be that a global programme should be developed with a view to helping State Parties identify those archaeological, and particularly prehistoric, sites that might be most credible as nominations to the World Heritage List on the basis of the archaeoastronomical evidence of their association with astronomy.

Ways forward

Many of the issues raised in this Thematic Study will, of course, need to be developed more deeply. In practice, some of this work will inevitably fall upon the writers of potential property nomination dossiers as part of their preparatory work of identification and study. To conclude this summary we wish only to underline a few additional points.

A key issue in the evaluation of a given property is whether its value (in the context of the World Heritage Convention) is local, national, or global. Astronomy, as we have discussed, is just one component among a range of attributes that might define the value of a site. In some cases it may be sufficient to consider the astronomical heritage in the context of the architectural heritage, with the astronomical devices being viewed as only one of a range of architectural attributes defining the value of the monument. The preceding discussion suggests, however, that it will more often be necessary to consider, in a comprehensive and consistent way, the various manifestations of astronomy that are embedded among a broader range of attributes with more complex interrelationships.

The new Intangible Convention adopted by UNESCO in 2003[5] may also provide a way forward. It aims to protect oral traditions and expressions, performing arts, social practices,

[5] UNESCO (2003). *Convention for the Safeguarding of the Intangible Cultural Heritage*. http://unesdoc.unesco.org/images/0013/001325/132540e.pdf.

rituals and festive events, knowledge and practices concerning nature and the universe, and traditional craftsmanship. To date, it has been mainly been applied to traditions such as pilgrimage and to collective practices concretised by local skills, such as traditional cooking and crafts. The inclusion of knowledge and practices concerning nature and the universe implies that it could and should be extended to scientific behaviours and methodologies.

This suggests in turn that the possibility should be explored of promoting inter-convention nominations for science heritage in general and astronomical heritage in particular.

We have already mentioned the possibility of updating the Management Systems of existing World Heritage Sites that may now be recognised as having astronomical value. For example, the new Management Plan for Stonehenge and Avebury recognises that Stonehenge's astronomical associations form an important aspect of the monument's overall significance, even though this was not part of the reason for its inscription. This leads to the recognition of the importance of maintaining as dark as possible a night sky, and of encouraging night tourism in relation to the site. This type of consideration may be appropriate in many cases.

Conclusion

Astronomy represents a rich and significant aspect of cultural and natural heritage. Recognising this permits us to identify and to clarify astronomical value in the context of the World Heritage Convention and raises serious possibilities of inscribing new properties on to the World Heritage List as well as re-evaluating properties already on the List.[6]

However, it also offers a profound new vision. It raises valuable new heritage concepts, combines different categories of cultural heritage in previously unrecognised and unexplored ways, and highlights hitherto unrecognised types of linkage between cultural and natural heritage. This has important implications for the more effective implementation of the Convention and for helping State Parties create credible nomination dossiers.

We believe that the principal aspects of the vision arising from this Thematic Study are applicable more broadly to science heritage in general, and indeed also to technology heritage (which in many cases has helped us to gain a better understanding of astronomical heritage). In drawing attention to the various issues and challenges in the context of astronomical heritage, it is to be hoped that the broader implications will also be thoroughly pursued. If so, this will be to the lasting benefit of the whole of science and technology heritage.

Select bibliography (recent publications)

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[6] The recognition of new types of OUV at these properties can only be achieved through re-nomination.