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SAAO
South African
Astronomical Observatory

**International Astronomical Union (IAU)
National Research Foundation (NRF)
Office of Astronomy for Development (OAD)**

**OAD Review 2014-2020:
Self-Evaluation Report**

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1. Executive Summary

The IAU Office of Astronomy for Development was established in March 2011 as a joint venture between the IAU and the NRF to implement the IAU decadal Strategic Plan, Astronomy for Development 2010-2020. The first phase of the existence of the OAD (up to the time of the first review in 2015 and the subsequent renewal of the IAU-NRF agreement) managed to achieve a transition from previous IAU activities in the area, a substantial amount of network building and strong international credibility for the concept. This culminated in the award of the Edinburgh Medal in 2016.

During the next phase (this review period) the OAD clarified the important difference between “astronomy for development” and the “development of astronomy”; consolidated its regional office efforts; strengthened its connection with the professional astronomy and development communities; refined the project proposals process and support for proposers; established flagship projects; and brought in development expertise into the OAD team to help shape all its activities.

The OAD has been cost-effective with a small coordinating office in Cape Town (4 full-time staff) demonstrating substantial influence globally. Since 2011, the OAD has coordinated IAU grants totaling **€851,959** for **160 projects** around the world, through its annual call for proposals, targeting audiences in more than **100 countries**. During this time the OAD has also established **11 regional offices** around the world (in Armenia, China, Colombia, Ethiopia, Jordan, Netherlands, Nigeria, Portugal, Thailand, USA and Zambia) with two of these offices serving as a joint language centre, and one serving as a dedicated language centre. During the same period, the OAD registered **over 600 volunteers** from around the world, and formed **17 partnerships** with organisations sharing in the OAD vision.

In terms of funding the OAD has managed to leverage more than it has cost the partners. The total combined OAD income from the IAU and NRF/DSI for its core operations over the review period amounts to **R20,368,221** (~€1,420,387), while the total amount leveraged through partners, grants and regions amounted to **R28,800,570** (~€2,008,422).

The accomplishments and visibility of the OAD have brought **substantial benefit** both to the IAU and to South Africa for what is a tiny fraction of national and international expenditure on astronomy and space sciences. The many **achievements, lessons** and **challenges** have enabled the OAD to better define the concept of astronomy-for-development and this has now been codified into the 2020-2030 IAU Strategic Plan, along with the goals of the OAD for the next decade. This plan represents a commitment by the IAU to continue the OAD until 2030. The OAD’s strategic location in South Africa has significantly benefited the continent, which is due to host, for the first time, an IAU General Assembly on African soil (in Cape Town, in 2024).

We recommend, taking into consideration the many aspects of the OAD’s performance and potential, as described in this document:

- i. the **continuation of the OAD at its current location;**
- ii. the **addition of one “development” staff member** (taking the total staff complement from 4 to 5);
- iii. the **renewal of the IAU-NRF agreement for a further 6 years;** until the 2027 IAU General Assembly
- iv. an **in-principle commitment from all parties, pending favourable reviews, to continue supporting the OAD at its current location until 2030** (which is the end of the current IAU Strategic Plan and the target for the UN Sustainable Development Goals, which the OAD strives to achieve).

The work of the OAD over the past decade involved a large number of individuals from around the world. We are deeply indebted to the many people who have contributed to this global effort.

2. The Evolution of the OAD

2.1. Background

In 2009 the IAU General Assembly in Brazil ratified a decadal strategic plan which centred around using astronomy to stimulate global development. A crucial element of the strategic plan was “*the creation of a small IAU Global Astronomy for Development Office*”. That same year the IAU issued a call for proposals to host the OAD. In May 2010 the IAU Executive Committee decided to accept the NRF proposal from among several that were submitted, and a few months later a 5-year agreement was signed between the IAU and the NRF to host the OAD at the South African Astronomical Observatory (SAAO) in Cape Town. The OAD began operations in March 2011 with the appointment of the director, and was inaugurated in April 2011 by then South African Minister of Science and Technology, Naledi Pandor. In 2015, following an external review of the OAD and its activities, the IAU-NRF agreement was renewed for a further 6 years, until the 2021 IAU General Assembly, with the next review (this one) scheduled for 2020. In 2018, following extensive consultation, the IAU adopted a new strategic plan for the 2020-2030 decade, in which the OAD remains a key component. Since the start of the OAD in 2011 its vision has been “***Astronomy for a better world***”. According to that new IAU plan “*This vision has been effective in communicating the purpose of the OAD’s work and that of the IAU’s Strategic Plan 2010–2020, and should be continued into the next decade.*” The mission statement adopted in 2011 is based on the “wheel” on the cover of the 2010-2020 Strategic Plan: “***The mission of the OAD is to help further the use of astronomy as a tool for development by mobilizing the human and financial resources necessary in order to realize the field’s scientific, technological and cultural benefits to society.***” Again, this encapsulates the spirit of the OAD’s work and its founding principles, and as such is something that should guide the way forward into the next decade.

2.2. Reflecting on the IAU Strategic Plan 2010-2020

The OAD was originally established to realise the IAU Strategic plan 2010-2020. As we now end the decade it is important to reflect, during this review, on this 2010-2020 strategic plan. Much has changed since that plan was ratified by the IAU General Assembly in 2009. An updated version of the plan was produced for the 2012 IAU General Assembly (a year after the establishment of the OAD), with a revision of nomenclature, an update on implementation, and the removal of dated appendices - it was already clear then that what we were learning at the OAD needed to be factored into the implementation of the original strategic plan. For example, the plan was originally titled “*Astronomy for the Developing World*”. As the OAD began operations and the importance of having a more global message in line with the spirit of the plan became clearer, so this was later (at the 2012 General Assembly) changed to “*Astronomy for Development*”.

During the 2015 review of the OAD¹ it was noted that the 2010-2020 plan itself is a visionary document which provides a guideline around which the OAD is built, rather than a detailed blueprint with instructions on implementation, and one of the subsequent review recommendations was that the OAD “*should engage critically in the debate on the relation between astronomy for development and development of astronomy, while developing its work globally.*” Part of the reason for this was the apparent lack of clarity in that plan in terms of whether the OAD should be about advancing astronomy or about advancing development. Even though the plan clearly aims to “*further UN Millennium Goals*” and impact positively on society, the goals listed for the decade seem to revolve instead around the growth of astronomy research and astronomy education.

¹ Full details of the 2015 review can be found at <http://www.astro4dev.org/oad-external-review/>

Following the 2015 review it was strongly concluded and emphasized by the various parties involved in the OAD, including the architect of the plan himself, Prof. George Miley, that the vision really was about what astronomy could do for development, such as stimulating broader capacity building and STEM education – and that *the OAD should be centred around the goal of using astronomy, in all its aspects, to advance development goals*. The renewed IAU-NRF agreement that emerged from the 2015 review contained a refinement of the tasks and objectives of the OAD which responded to the changing times, lessons and greater clarifications since the IAU Strategic Plan was ratified in 2009.

The 2015 IAU General Assembly recognised that *“the OAD has successfully promoted an ambitious international programme of activities in pursuit of the objectives of the IAU Strategic Plan”* and resolved that a new strategic plan be presented to the 2018 IAU General Assembly. By 2017 the process was underway to capture all the lessons from the OAD, the changing landscape (such as the existence of other IAU offices²), and the overall ambitions of the IAU, into a clearer and more holistic plan for the 2020-2030 decade. This new strategic plan contains a very specific development mandate for the OAD and will guide future activities until 2030. At the time of writing the IAU now has four offices (OAD, OAO, OYA and OAE) in line with and guided by the 2020-2030 strategic plan. The IAU mission statement has also been updated with words in parenthesis to emphasise the expanded scope of its activities: *“The mission of the International Astronomical Union is to promote and safeguard astronomy in all its aspects (including research, communication, education and development) through international cooperation”*

All this has been a natural evolution of the visionary 2010-2020 Strategic Plan, which has laid the path for its clearer and stronger successor, the 2020-2030 strategy. Through the 2010-2020 decade the IAU has set an example for other “blue skies” scientific fields to follow, by demonstrating that any field of science can have a significant and direct impact on society, as long as there is commitment to do so. One could not have predicted in 2009 the incredible amount of global activity and valuable insights that would be derived from the OAD community with regard to using astronomy as a tool for development. The foresight and visionary leadership that enabled the IAU to take the leap into this area of astronomy-for-development has had a significant impact globally, and should be celebrated. It was the spirit embedded in that original plan, of service to society, that has driven the OAD over the past decade.

2.3. OAD Philosophy and Context

Following the discussions and reflections around the 2015 review, it was concluded by the OAD’s oversight structures, that the primary goal of the OAD was indeed “astronomy for development,” but that the “development of astronomy” was still something that happened along the path to that primary goal. In other words, in order to use astronomy for development, one needed to first have some form of astronomy in place. The new IAU Strategic Plan 2020-2030 makes clear this primary goal of the OAD to use astronomy to impact on development.

To have a common understanding of what is meant by “development” the OAD has aligned with the UN Sustainable Development Goals (SDGs) as adopted by the UN in 2015. These goals may have their flaws, but remain the widely accepted understanding of development. Given that the SDGs are for the period 2015 to 2030 it has also been chronologically convenient to use the SDGs as the development goals in the new 2020-2030 IAU strategy. Some potential contributions of astronomy to the SDGs include, for example, capacity building workshops addressing SDG4 (Quality Education); Astro-

² The IAU Offices are the Office for Astronomy Outreach (OAO); Office for Young Astronomers (OYA); Office of Astronomy for Education (OAE); and Office of Astronomy for Development (OAD)

tourism addressing SDG8 (Decent Work and Economic Growth); activities targeting under-represented groups addressing SDG10 (Reduced Inequalities); etc. In taking on the challenge of the SDGs, and keeping with the OAD's guiding principle of humility (which has been written into its planning documents from the very beginning), it has always been important to see astronomy-for-development as one part of the bigger "science for development" context. According to the new IAU Strategic plan, *"The IAU is well positioned to lead this global conversation on science for development. The field of astronomy can lead other sciences in terms of the societal benefits of blue skies research, and also with regard to the value that science brings to challenges facing humanity. The OAD can be a "working space" for collaborations across sciences."*

The 2018 merger of the International Council for Science (ICSU) with the International Social Science Council (ISSC) into the new International Science Council (ISC) demonstrates the global recognition of the importance of sciences working together across disciplines to achieve greater outcomes. This is illustrated in the 2020-2030 IAU Strategic Plan: *Different scientific disciplines have different tools that they use in their fields. There are many overlaps, with similar tools being used in different disciplines. These tools can be used collaboratively to drive various actions. The actions in turn will influence one or several of the SDGs.*

However, another key part of the equation is the importance of the interface between astronomy and development practitioners, such as development economists, relevant government structures and NGOs. Astronomers may know astronomy well, but they need expertise from partners in order to efficiently apply their astronomy skills, methodologies, technologies, etc to addressing development challenges. ***Stimulating these development-oriented partnerships is vital to achieving development outcomes.***

3. The OAD today

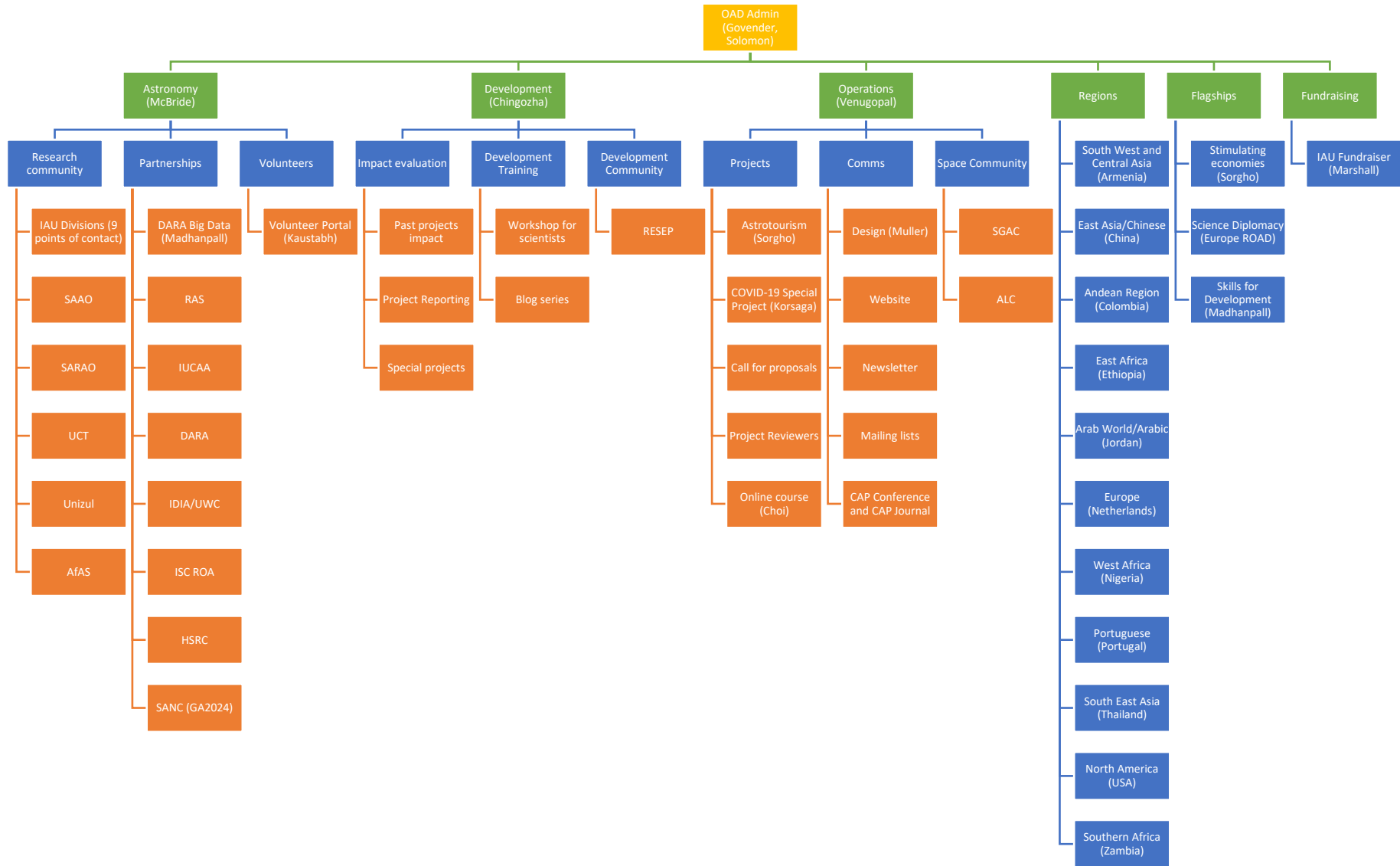
The OAD currently operates with four core staff members (Govender, McBride, Solomon, Venugopal) and, at the time of writing, four OAD Fellows³ (Chingozha, Korsaga, Madhanpall, Sorgho). Oversight of the OAD is shared between the IAU and the NRF, with the OAD Steering Committee made up of 3 nominees from the IAU (currently Ajit Kembhavi, Daniela Lazzaro, José Miguel Rodriguez Espinosa), 3 from the NRF (currently Bernie Fanaroff, Renée Kraan-Korteweg, Saalih Allie) and the SAAO Director as an ex-officio member (currently Petri Vaisanen). The Steering Committee has an annual face-to-face meeting where the OAD presents its activities and business plan for the next financial year.

There is also an annual high-level meeting between the IAU (represented by at least the President and General Secretary) and NRF (represented by at least the CEO and Deputy CEO: National Research Infrastructure Platforms). The IAU-NRF agreement contains an illustration of the high-level structures. The only aspect that has changed is that the OAD Task Forces have now been replaced by a single panel of reviewers which includes development expertise. In order to get a more detailed picture of the OAD itself, one has to look at a more global (functional) organogram as shown in Figure 1. This basically shows six core areas or functions under which the main OAD activities fall: **Astronomy; Development; Operations; Regions; Flagships; and Fundraising.**

Although each of these core areas or functions are driven primarily by one of the OAD team members, there are sometimes overlaps where some team members contribute to different core areas. Responsible persons at the time of writing (including staff, fellows, volunteers) are indicated in brackets in Figure 1, and each of these core areas or functions are discussed thereafter.

³ OAD Fellows typically work full time, for a few months, usually associated with specific projects. We have also had several interns and volunteers who are shorter-term or part-time.

Figure 1: Functional Organogram of OAD as at June 2020



3.1. Astronomy

The 2015 review had recommended the appointment of an astronomer to strengthen the links with the professional astronomy **research community**. Following the relevant appointment processes, the position was filled at the beginning of 2017 by OAD Astronomer Dr Vanessa McBride, who holds an Adjunct Associate Professor position at the University of Cape Town (UCT). Dr McBride's strong connection with UCT and SAAO has ensured that this envisaged role has been well fulfilled. Under this area of activity, the OAD maintains close interactions with key astronomy groups locally (SAAO, SARAQ, UCT)⁴, regionally (AfAS) and internationally (IAU Divisions). The OAD also interacts closely with emerging astronomy initiatives at historically black universities in South Africa, such as University of Zululand. This is important for South Africa, as well as providing learning opportunities for similar initiatives in other parts of the world.

The OAD Astronomer is also responsible for initiating and coordinating various **partnerships** which require an astronomy background. A full summary of all the OAD's partnerships is given in Appendix A6. There are also special projects that are better driven by an astronomer. Some examples are

- (i) AstroSense (an initiative led until 2019 by postdoc Dr. Wanda Diaz-Merced regarding accessibility and inclusion),
- (ii) the OAD Data Science Toolkit (an initiative led in 2017 by OAD Fellow Dr. Paul A. Wilson to bridge the gap between astronomy and data science),
- (iii) AstroVarsity (a project relating to the use of astronomy for Physics teaching).

The OAD Astronomer is also responsible for coordinating **volunteers** who wish to contribute to global OAD activities (we currently have a database of over 600 volunteers). This activity has taken the form of an online volunteer portal through a partnership with IUCAA, where volunteers and people seeking such volunteers can connect with each other.

3.2. Development

The need for this area of activity was identified in the first few years of the OAD and has been crucial to bridge the gap between astronomy and development communities. From 2014 to 2017 this was led by Dr Elizabeth Grant whose expertise was in impact evaluation of development projects, and who really helped shape the OAD's understanding and trajectory around development, such as the need to align with the SDGs. After she left the OAD, the gap was partially addressed through a partnership with RESEP, a Development Economics group at the University of Stellenbosch. However, it was only in 2019 that this role was more adequately fulfilled, when Dr Tawanda Chingozha, then a PhD student at RESEP, joined the OAD as a Development Economics Fellow. Under this area of OAD activity, Dr Chingozha has picked up on the **impact evaluation** aspects initiated by Dr Grant, but looking more at practical implementation such as

- (i) a qualitative assessment of the impact of past OAD projects;
- (ii) the redesign of OAD's project reporting to gather more specific impact-related data;
- (iii) the implementation of special projects such as an assessment of the societal impact of the Sutherland Observatory.

Chingozha has also initiated **development training**⁵ activities, in order to help scientists and others better understand what development means, and thus be better able to apply their skills and tools to

⁴ SAAO=South African Astronomical Observatory; SARAQ=South African Radio Astronomy Observatory; AfAS=African Astronomical Society; DARA=Development in Africa with Radio Astronomy; IUCAA=Inter-University Centre for Astronomy and Astrophysics; RESEP=Research in Socio-Economic Policy

⁵ See <http://www.astro4dev.org/introduction-to-development-economics-short-course/>

societal challenges. This training has taken the form of a short workshop delivered both in person and online, as well as a series of blogs which address various relevant topics in layperson language. Initiating and maintaining interactions with the **development community** remains a key activity for the OAD.

3.3. Operations

The growth of the global OAD community over the years has meant that our operations needed to be efficient and well communicated across the world. Following a somewhat intense first few years of the OAD, when human resources were stretched to the limit in keeping operations smooth, the first OAD review recommended some relief in the form of a modest increase in staffing. Ramasamy Venugopal joined the team in 2015, initially as an OAD Visiting Fellow, and then later as our current Operations Manager. He has been able not only to optimize our call for proposals process into a smoothly operating machine, but also to professionalize OAD communications. This area of OAD activity includes all aspects related to **projects** including the annual call for proposals with its application and review process, and the related online course for project proposers (which is led by OAD volunteer Jane Choi). A detailed description of the annual call is included in Appendix A3. This area also includes special projects such as

- (i) the astro-tourism part of the flagship on using astronomy to stimulate socio-economic development in small communities (coordinated by OAD Fellow Dr Amidou Sorgho);
- (ii) the special COVID-19 project led by OAD Fellow Dr Marie Korsaga, exploring ways in which astronomy and other non-medical sciences could contribute to addressing challenges caused by the pandemic;
- (iii) the 2016 One World Experiment which was an attempt to test, using more rigorous evaluation techniques, whether the perspective that astronomy gives would change a young person's empathy towards those from outside their normal groups.

The **communication** aspects of OAD operations includes

- (i) professional design for communications (coordinated by OAD Fellow Annika Muller);
- (ii) maintaining the extensive OAD website;
- (iii) producing a quarterly newsletter for the global OAD community;
- (iv) maintaining several mailing lists related to OAD's work; and
- (v) maintaining a close collaboration with the Communicating Astronomy with the Public (CAP) community, both in terms of the CAP conference and CAP journal.

A special network that Venugopal has brought to the OAD is that of the **Space community**. Through his role in the Space Generation Advisory Council (SGAC) the OAD was able to form a partnership around common interests, especially in the area of Space for Development. Venugopal is the point of contact for the OAD for all interactions and possible collaborations with the Space community, such as the African Leadership Conference on Space Science and Technology for Sustainable Development.

3.4. Regions

A central aspect of the astronomy-for-development endeavour is the establishment of Regional Offices of Astronomy for Development (ROADs) and Language Expertise Centres of the OAD (LOADs). The principle is that it is not possible for the OAD on its own to understand the needs and nuances of every part of the world, so a ROAD (for a geographic region) or LOAD (for a language/cultural region) would be the regional coordination point. These ROADs and LOADs are able to advise the OAD on the specific needs of the region. Should a project, such as one of the OAD flagship projects, be ready for expansion, then these offices would form the backbone for a "rollout". To date there have been **11 ROADs/LOADs** established around the world (in Armenia, China, Colombia, Ethiopia, Jordan, Netherlands, Nigeria,

Portugal, Thailand, USA and Zambia) with two of these offices serving as a joint ROAD/LOAD, and one serving as a dedicated LOAD. A **combined business plan**⁶ with contributions and input from all offices has been adopted as a foundation for collaboration and alignment. This document describes all the offices in detail, is updated annually, and includes sections such as oversight structures, staffing, strategic goals, operational objectives and indicators, challenges, risk analysis, budgets, etc for each office. The OAD Director serves as an ex-officio member of each of the regional oversight committees. Representatives from all eleven offices meet in person at least once every 18 months (basically once at every triennial IAU General Assembly and once between General Assemblies). A quarterly meeting also held with all regional coordinators to provide updates and address concerns or challenges that may come up – these are all mechanisms for maintaining coherence of the OAD vision across a diverse set of offices. All these interactions stimulate synergies and collaborations among offices from different geographic and cultural regions, thus making the whole greater than the sum of its parts (an example being a recent successful proposal for EU funding, led by the Europe ROAD but submitted jointly by 5 ROADs). ROADs/LOADs sign agreements with the IAU that are reviewed regularly⁷. A summary table with descriptions of all the regions and the status of reviews of each office, is given in Appendix A5.

3.5. Flagships

Part of the OAD’s strategy is to coordinate global “flagship” or “signature” projects, which would be implemented on a much larger scale than those funded through the annual call for proposals. Well-formulated flagships should be supported through external fundraising and are seen as an effective means for achieving impact of astronomy for development over a substantial part of the world. In 2019 the OAD identified five flagship themes that encapsulate the idea of astronomy for development, and which have the potential for global roll-out. The selection of these themes was based on the experience gained from supporting 140 projects (and reviewing about 1000 proposals) from 2013 to 2019, input from the then 10 regional offices around the world, and informed by special OAD projects, partnerships, international trends, etc. The five themes that emerged from this review and consultative process are:

1. **Stimulating economies (e.g. astro-tourism, observatories for communities, etc)**
2. **Science diplomacy (e.g. peace, post-conflict, partnerships, policy, etc)**
3. **Knowledge and skills from astronomy (e.g. data science, teacher training, schools, etc)**
4. **Technology from astronomy (e.g. software, water, solar, dark skies, etc)**
5. **Addressing inequality (e.g. gender, geographic, ability, etc).**

Following discussions with the OAD Steering Committee in February 2019, it was decided that there should be an initial focus on two of these themes (**numbers 1 and 2 above**). During 2019 two OAD Fellows, Dr Amidou Sorgho and Amelia Henkel, completed desktop studies on the two respective flagship projects, placed them online and identified lists of potential partners. They then developed implementation models and contacted those potential partners. Conversations proceeded with the European ROAD in terms of the flagship on Science Diplomacy (the European ROAD is coordinating a project entitled “Pale Blue Dot” which has similar objectives), and the Global Himalayan Expedition in terms of the flagship on socio-economic development in small communities (based on an OAD-funded project using astronomy to attract tourism in rural parts of India). Due to a partnership with DARA Big Data, which funded a new OAD Fellow (Dr Nikhita Madhanpall), we launched a 3rd Flagship in January 2020 on astronomy knowledge and skills for development (**number 3 above**). All flagships were presented to the 11 regional offices at their face-to-face meeting in January 2020, with the intention that these offices would help drive these projects in their regions. The 2020 call for proposals includes the opportunity for proposers to respond to all three flagships.

⁶ The latest version of this combined business plan is submitted as additional material for the OAD review.

⁷ In 2016 the IAU allowed that agreements can remain in place until the respective reviews were completed.

3.6. Fundraising

According to the IAU-NRF agreement in 2015, “IAU shall appoint a part time staff member (or outsource an equivalent service) dedicated to fundraising in consultation with the OAD (Steering Committee and Director)”. In December 2017 Dr Jorge Rivero Gonzalez was appointed as the coordinator for the IAU’s 100th Anniversary celebrations (IAU100). Part of his time was allocated to the OAD to fulfil the fundraising role. However, since he was also responsible for raising funds for IAU100, there was limited focus or time available for OAD-specific fundraising. A positive outcome was the funding of 3 projects, previously funded by the OAD, to expand globally as part of IAU100 celebrations (€10,000 each). Gonzalez completed his IAU100 role in February 2020, and in April 2020 Genevieve Marshall joined as the part time **IAU fundraiser**. Marshall comes from a background of raising funds for NGOs (as compared to Gonzalez who was an astronomer). Since Marshall’s start it has become abundantly clear that this was the expertise and networks we had been lacking for effective fundraising in the past. Although her current mandate involves fundraising for all IAU activities, we are optimistic that her vast experience and incredible network will help raise the funds needed specifically for expansion of OAD projects and activities. A point to note is that Marshall will only be in the position until the 2021 IAU General Assembly. It is important, however, that the fundraiser position be continued beyond 2021.

4. Achievements

Some highlights of the OAD’s achievements during this review period are listed here:

- 4.1. Clarity of mandate:** This may seem trivial but the transition from previous IAU activities to the era of the OAD was not an easy one, and involved sensitive, strategic and diplomatic management of relationships. The 2010-2020 strategy was also vague as to the difference between astronomy for development and the development of astronomy, which did not help. A significant achievement therefore was to obtain this clarity of mandate which is now captured in the 2020-2030 strategic plan and revised IAU mission statement, as adopted in 2018.
- 4.2. Astronomy-for-Development is a “thing”:** From a big picture perspective, an important achievement of the OAD (and the IAU/NRF) has been to establish the concept of astronomy-for-development as a recognizable area of activity for the global astronomy community. This has taken engagements with politicians, funders, scientists, NGOs and other stakeholders to a different level. The work of the OAD has often been cited or we have been called upon when the question is asked about what the societal impact of astronomy is. Armed with numerous examples from the many funded projects, the OAD is able to demonstrate practical on-the-ground examples of using astronomy to stimulate development.
- 4.3. Regions:** Establishing and coordinating 11 offices around the world has not been a small task. Although there are definitely things we could do better, the establishment of these structures, involving agreements with partner institutions, regular meetings, consideration of regional specificities, alignment of visions, reviews of activities, and even conflict resolution, has been a significant achievement. In particular, ensuring that there are offices located not only in regions with emerging astronomy communities, but also in the astronomy “hubs” such as Europe and North America, has meant that a truly global, diverse structure can work as a united team, bringing to the table strengths from around the world, to use astronomy for development.
- 4.4. Rallying a global community:** The work of the OAD has rallied a significant global community via its 11 regional offices, over 1000 project proposals, 160 funded projects, over 600

volunteers, and numerous other partners and stakeholders. They have all been brought together under the guiding vision of using astronomy for development.

- 4.5. **Flagships:** Through engagement with its global base, and building on the experience of funded projects, the OAD has identified and developed flagship projects to be expanded upon (see 3.5).
- 4.6. **Building partnerships:** The OAD has managed to build partnerships with a diverse range of organisations from several disciplines including astronomy, space science, development economics, social sciences, and others (see Appendix A6 for a list of 17 key partnerships).
- 4.7. **Smooth call for proposals system:** Each year since the first call for proposals was issued in 2012, the OAD has been constantly improving the “machinery” of the process, to optimise between user-friendliness and quality proposals. The current system operates smoothly and processes over 100 proposals per year during a now two-stage call process. The management of the call process (which includes consultations with stakeholders, design of call, online application system, publicity, review process, grant agreements, payments, project reporting, etc) is not to be taken for granted and enormous credit is due to OAD Operations Manager Venugopal for what is now a very smoothly operating system.
- 4.8. **Support for proposers:** A key part of the call for proposals is developing capacity within a global community of applicants, some of whom have rarely submitted any funding proposal, such that they can learn and grow through the process as well. The suite of support that has been established includes an online training course; resources to help understand development; a two-stage call process where the OAD, its regions and partners assist proposers to improve project ideas; a searchable resources database with material from all past projects; and of course an ever-willing team at the OAD who handle numerous queries from the community.
- 4.9. **Impacting on society:** Measuring impact is not an easy exercise but we have been able to do a qualitative assessment of impact. An initial assessment has been carried out for past OAD projects⁸ and a more comprehensive framework is in now place (see Appendix A4). To get an idea of the type of projects we support, readers are encouraged to browse through the OAD website to see examples of projects with photos, summaries and project reports. Several “glossy” resources have been produced to highlight a few interesting projects and they can be downloaded at <http://www.astro4dev.org/downloads/>.
- 4.10. **Focus on Africa:** The 2010-2020 Strategic Plan talks about a focus on Sub-Saharan Africa due to its relatively low average levels of development. Since this region hosts the OAD, it has enabled such a focus to happen naturally. Related achievements include the OAD’s facilitation for the establishment of the African Astronomical Society (AfAS), and the support provided to the IAU National Committee in South Africa during their successful bid to host the 2024 IAU General Assembly. Through a partnership with DARA the OAD also coordinates a special call for development projects in SKA Africa partner countries.
- 4.11. **Interdisciplinary collaborations:** A significant achievement has been in partnering with the International Science Council’s Regional Office for Africa to bring together numerous disciplines at a Science-for-Development workshop in January 2020. Apart from this, the OAD has partnered with organisations outside astronomy such as HSRC, SGAC and RESEP⁹.

⁸ Details on the initial impact assessment is available at <http://www.astro4dev.org/projects-impact/>

⁹ Human Sciences Research Council (HSRC), Space Generation Advisory Council (SGAC) and Research in Socio-Economic Policy (RESEP). See details of these partnerships in Appendix A6

- 4.12. Team in Cape Town:** One of the most significant achievements, that is not to be taken for granted in any way, is that the OAD has managed to establish a truly exceptional team at the Cape Town office. For a small office with a big mandate it is essential to have a diverse team (diverse in both skills and backgrounds) that is not only highly motivated and efficient, but also where individuals get along well and support each other, especially in times of working under pressure or when individuals have to deal with unforeseen personal circumstances. *The positive spirit and efficiency of the OAD team in Cape Town receives endless recognition and praise from all our stakeholders. Whatever the OAD has achieved is really a credit to them.*¹⁰
- 4.13. Edinburgh medal, publicity and other recognition**¹¹: In 2016 the work of the OAD was internationally recognised through the award of the Edinburgh Medal “jointly to Kevin Govender and the IAU” for the creation and practical establishment of the OAD, “which integrates the pursuit of scientific knowledge with social development for and with those most in need.” This award received special recognition by the South African Parliament. OAD Fellow Dr Wanda Diaz-Merced was invited to the White House Frontiers Conference hosted by US President Barack Obama in 2016, and later, in 2017, was featured by BBC 100 Women as one of seven trail blazing Women in Science. In 2017 Phil Charles, Patricia Whitelock, Khotso Mokhele, and Kevin Govender were given a special award by the Minister of Science and Technology for their contributions to South Africa being selected as the host of the OAD. The OAD was also featured in several publications including Nature Astronomy¹², Astronomy and Geophysics¹³, and The Conversation¹⁴, and has appeared in numerous news media online¹⁵, as well as in print, radio and television.

5. Challenges

During the review period there have been several challenges, which have affected the OAD’s output in one way or the other. Some of the main challenges are briefly described here.

- 5.1. Visa for Venugopal:** Following the NRF appointment process Venugopal was offered a key OAD position at the end of 2017, to coordinate OAD Operations. Unfortunately, his application for a work permit faced numerous setbacks which resulted in extensive delays. Venugopal kindly continued serving the OAD from one of our partner institutions, IUCAA, in India. The difficulty in obtaining visas was highlighted in the 2015 review of the OAD, where exactly such risks were foreseen by the review panel. Venugopal finally arrived in South Africa at the end of January 2020, on a 3-year visa, over 2 years after he was initially offered the position.
- 5.2. Unfilled positions:** The 2015 review recommended the appointment of a full-time astronomer and part-time fundraiser. We were only able to fill the astronomy position in January 2017. The fundraiser role was also empty until the end of 2017 although, as explained in 3.6, the time allocated for the OAD was not practically achieved. During 2017, Dr Elizabeth Grant’s position

¹⁰ Details of the OAD team, including current and past team members, at <http://www.astro4dev.org/oadteam/>

¹¹ More details on OAD awards and recognition at <http://www.astro4dev.org/awards-recognition/>

¹² McBride, et al 2018 (<https://rdcu.be/2oE5>) and Alves-Brito, et al 2019 (<https://www.nature.com/articles/s41550-019-0736-9>)

¹³ Q&A with Govender (<https://academic.oup.com/astrogeo/article/57/3/3.43/1741960>)

¹⁴ McBride, 2018 (<https://theconversation.com/a-big-moment-for-africa-why-the-meerkat-and-astronomy-matter-99714>)

¹⁵ Press releases and some links at <http://www.astro4dev.org/press-releases/>. Or use Google search for news.

was empty for most of the year due initially to maternity leave, followed by her resignation. Although Venugopal was appointed at the end of 2017, we were unable to pay him a normal salary (due to visa challenges mentioned above) until 2020. These unfilled positions placed a strain on the OAD team but thanks to the commitment and dedication of several volunteers, fellows and interns, we were able to sail through. It did leave us with unspent funds though (see overview of core funding in Appendix A1).

- 5.3. Fundraiser:** As described in 2.6 there was a challenge of not having sufficient time from the first IAU-appointed fundraiser, due to his commitments to the IAU100 celebrations. It was also not clear how the OAD could effectively use his time since his experience in fundraising was quite limited (he was an astronomer by training). It became apparent in 2020, when an experienced fundraiser was appointed, that, looking retrospectively, this was an area that had suffered in the past due to the lack of relevant fundraising skills being on board.
- 5.4. Coordinating Regions:** The OAD has sometimes struggled to align all the regional offices (each with very different and sometimes evolving hosting arrangements) with a single understanding of astronomy for development (especially as compared to the development of astronomy). Although huge progress has been made, the OAD could do better in providing clearer direction in order to help consolidate local objectives with global ambitions. Good practices from regions could also be shared better, beyond the regular meetings, so that one office can better learn from another within the OAD network. Also, these offices are constantly faced with funding challenges, which has become a regular topic of discussion. We are hopeful that, with the IAU fundraiser appointed in 2020, this will be addressed.
- 5.5. OAD Director personal circumstances:** In January 2018 the OAD Director's wife was diagnosed with pancreatic cancer and underwent emergency surgery. This rollercoaster battle with cancer for the relatively young family (kids were 3 and 5 years old then) included two resurgences, three different chemotherapies, three more surgeries and numerous hospitalisations in the years since the diagnosis. This meant that there was a non-negligible impact on the OAD's overall performance. Thankfully, with the excellent support and capability provided by the rest of the (small) OAD team, as well as systems in place to keep operations going, the OAD has still been able to fulfil its commitments to its global community of stakeholders.
- 5.6. Continuity across IAU leadership:** A point that has been discussed over the years is that there can sometimes be a lack of continuity across the changing leadership of the IAU, which can have an influence on the operations of the OAD due to different personalities or priorities (IAU officers change every 3 years). However, this challenge has not been as pronounced during this review period as it was prior to 2015, when the new IAU-NRF agreement addressed this somewhat. The matter is mentioned here for completeness, because it could be something to be aware of for the future. It must be noted that engagements with IAU Officers on this have been very positive, and any potential future risks have been largely addressed through the clarification of OAD mandates and goals in the 2020-2030 IAU Strategic Plan.
- 5.7. COVID-19:** Towards the end of the review period the COVID-19 pandemic brought much of the OAD's activities to a halt due to travel restrictions and lock downs in most countries in which we operate. The OAD has had to reinvent itself somewhat to respond to these changing times and continues to reflect on building resilience in activity for an uncertain future society. While presenting a challenge for the status quo, the pandemic has also been an opportunity for astronomy to play a greater role in development due to the vast amount of related needs that have arisen around the world. The future direction of the OAD has to take this into account.

6. Lessons

As we end the 2010-2020 decade and embark on the next, it is important for us to reflect on what we have learned so far in order to shape the future. The OAD was a new venture for the IAU and in many ways we had to not only pave the way for astronomy, but also for other sciences in terms of asking how our field contributes to development.

- 6.1. Defining Development:** The first challenge we faced was in the definition of development itself. Although the 2010-2020 strategic plan explicitly mentioned the Millennium Development Goals, and spoke of accessing development funding, we had virtually no connection with the development community. Much of the original strategic plan was based on the assumption that the development of astronomy would ultimately equate to a direct impact on development. We learned that this was not a strong argument to make when trying to engage with the development community, especially development funders. It was also insufficient to convince governments and policy makers to invest in or support astronomy - we really needed to show how astronomy impacted development. We therefore aligned with the 17 UN SDGs in 2015. The SDGs are far more robust than their predecessors, the MDGs. They are widely accepted by governments and often form the starting point of any conversation about development. There are also clear indicators which break down the SDGs into targets against which we can map astronomy's contributions.
- 6.2. Outreach vs Development:** The astronomy communities we work with had not really engaged with the idea of astronomy-for-development before the OAD. Most people were familiar with "education and public outreach" (EPO) and placed the OAD into that "box". This meant that many project proposals to the OAD were either traditional EPO activities or activities aimed at promoting astronomy and careers in astronomy. However, this has now been clarified in the 2020-2030 IAU Strategic Plan, and especially with the existence of now four IAU offices.
- 6.3. Interdisciplinarity:** The "wheel" on the cover of the original strategic plan expresses the interdisciplinary nature of astronomy. However, there has been limited appetite within the community to effectively collaborate with other disciplines, as judged by project proposals we receive and our experience in trying to stimulate such conversations. While some collaborations are natural and obvious, such as with the Physics community, others are more difficult, such as with the social sciences. What we have learned is that without cross disciplinary conversation, not only within natural sciences but also (and especially) with social sciences and development organisations, the idea of astronomy for development will not be fully realised.
- 6.4. Positioning "Astronomy-for-Development":** The IAU is well positioned to foster global conversations on science for development, with the OAD widely recognised as a pioneering endeavour in this area. The astronomy field can thus support other sciences not only in terms of the societal benefits of blue skies research, but also with general conversations around the value that science brings to addressing challenges faced by humanity. The OAD provides a "working space" for collaborations across the sciences. As such it is a practical example of the value of initiatives like the formation of ISC (whose vision is to "*advance science as a global public good*"). This OAD position can thus be leveraged over the next decade to drive similar structures and conversations outside the astronomy field. A major event in this spirit was the workshop on Science for Development, in partnership with ISC Regional Office for Africa¹⁶.

¹⁶ More information on ISC and the workshop at www.science4dev.org

- 6.5. Projects:** The open annual call for proposals has proven very popular with significant oversubscription rates. There is also clearly a large passionate community who are willing to drive projects either in their spare time or as part of their daily jobs. What we find though is that the community is in need of support regarding the understanding of how a project idea can be shaped into an intervention that delivers maximum impact, and importantly, how that impact can be measured. Although some projects show promise for expansion, we have found that many do not quite address a specific development issue. Projects often do not spend much effort exploring the needs of their target audience before designing their projects. This suggests that there needs to be a mix of top-down and bottom-up approaches in the design and implementation of projects. The two-stage call for proposals process, the online course for proposers and the flagship projects have helped to address this.
- 6.6. Regions:** It is clear from our experience with now 11 regional offices and language centres that diversity is a strength, with numerous ideas and best practice spreading across language and geographic boundaries. Diversity at this level can also be a challenge, especially due to different working cultures. Establishing a common language or vision can be difficult since regional structures are sometimes (understandably) influenced by local priorities, strategies or goals. There can also be complexities and sensitivities within a region as a result of varying expectations or conflicts of interest. These have to be addressed on a case by case basis and is most effectively done in person, with an appropriate amount of diplomacy. However, we have seen that the regional offices and language centres still remain an excellent structure for dissemination and feedback. We have learned that using a common business plan, regular meetings and the principle that regional coordinators are a key part of the global “management structure” of the OAD, has helped to maximize the synergy and align the various activities.
- 6.7. Volunteers:** The management of volunteers has been a challenge for the OAD. The large number registering on the OAD website resulted in a great deal of time needed to find opportunities to match volunteers’ interests and skills. There was also a clear vacuum when it came to funding. Often volunteers would approach the OAD with ideas but would require funding to implement them. Volunteers willing to travel to give lectures or talks (there were many of them) mostly needed funding to cover those travels. As a result, we encouraged volunteers to submit proposals to the annual call and seek funding in that way. Having said that, there were also several volunteers who became involved in providing advice and guidance at a distance (e.g. through valuable mentorship efforts) to projects and individuals around the world, as well as some who found alternative funding for their ideas. We have concluded that an online volunteer management system was needed to make this activity sustainable, ideally with a separate pot of funding to support those volunteers.
- 6.8. Partners:** During the first 5 years of the OAD’s existence, partnership agreements were signed with nine different organisations. These were for various collaborative projects which helped greatly to increase the pool of resources available for project proposals. A major lesson we have taken from these partnerships has been the large amount of time required to manage each of these agreements. In 2017, with the appointment of the OAD Astronomer, these partnerships were nurtured and renewed or updated where necessary. Virtually all these partnerships arose in an ad hoc manner though, and was in part driven by the goals of the respective partners (who were all related to the astronomy field). Since then more diverse partnerships from outside the astronomy field have been put in place (see Appendix A6). We have learned that the OAD can play an important role in connecting both astronomy and development organisations through our relations with each respective group, and as such can drive interdisciplinary partnerships.

- 6.9. Task Forces vs Review Panel:** The 2010-2020 Strategic Plan described three Task Forces (universities and research; children and schools; general public). While these Task Forces were very useful in thinking about the IAU as a whole at the time, they seemed, from the OAD's experience, to make it difficult for astronomy-for-development projects. This is mainly because proposers, since 2015, were trying to use astronomy to address the SDGs, while the Task Forces aligned more with the development of astronomy at all levels of education. Projects that would find it difficult to align to one of the three Task Forces include those related to science diplomacy, community development, and the application of astronomy techniques in the medical field. We have learned that for OAD projects, a single review panel with a wide range of expertise, is more effective than the three specific Task Forces.

7. Response to 2020 Review Dimensions

This section responds to the points in Section 7 of the Draft Terms of Reference for the 2020 Review.

7.1. *Management, coordination and evaluation of the IAU programs worldwide in the area of development and education, including recruiting and mobilizing participating volunteers.*

- **Call for proposals:** The main area of activity in response to this review dimension is the annual call for proposals managed by the OAD and funded by the IAU. All funded projects are managed and coordinated from the OAD, with the support of its regional offices and partners. Details on the management of the call and the statistics over the review period can be found in Appendix A3.
- **Impact cycle:** In response to the need for evaluation of the impact of projects the OAD established the Impact Cycle in 2015 (significantly expanding from its previous Monitoring and Evaluation Framework). This impact cycle (see Appendix A4) describes the route to be followed for projects regarding evaluation of impact. We have provided guidelines for all projects, including an online course, such that they are able to implement either full impact evaluation (with partners) or basic monitoring and evaluation as applicable.
- **Evaluation of past projects:** The OAD has conducted a qualitative assessment¹⁷ of the impact of all past projects exploring both the implementation quality (has the project delivered as promised) and the potential impact on development (has the project had an impact on society). Through the support of Development Economist Fellow Tawanda Chingozha, a new online reporting system has been put in place for projects to enable both qualitative and quantitative evaluations in future.
- **Volunteers:** The OAD has managed its (over 600) registered volunteers initially through dissemination of opportunities via a mailing list. Later a volunteer portal¹⁸ was developed through a partnership with IUCAA. This portal can be used by all OAD stakeholders (project leaders, partners, regional offices, IAU offices, etc) to request for a volunteer's time. Volunteers have always been encouraged to use the OAD's annual call for proposals to apply for the funds required to implement their activities.

7.2. *Organization of oversight of the IAU development programs and the formulation of their annual budgets.*

- **Projects:** This relates to the previous review dimension. The oversight of projects is conducted in consultation with the OAD reviewers, regional offices and OAD Steering Committee. Budgets are determined at the outset and financial reports are submitted at the end, with midterm reporting and occasional requests for information also required.

¹⁷ Full assessment and interactive infographics available at <http://www.astro4dev.org/projects-impact/>

¹⁸ More information on volunteers and the link to the portal at <http://www.astro4dev.org/volunteers/>

- **Flagships:** The OAD has identified flagship projects which it has been developing for global rollout. These flagships are described in Section 3.5 and at the time of writing do not have detailed annual budgets as yet, but are being developed in collaboration with partners and the IAU fundraiser.
- **Special Projects:** The predecessors of the Flagships were special projects/programmes/pilots that were incubated and managed within the OAD, with the same objective of eventual global reach. These were selected based on gaps identified, funded projects which show promise for expansion, availability of coordination staff and funding. Some examples are AstroSense (an initiative led by postdoc Dr. Wanda Diaz-Merced regarding accessibility and inclusion), the OAD Data Science Toolkit (an initiative led by OAD Fellow Dr. Paul A. Wilson to bridge the gap between astronomy and data science), AstroVarsity (a collaboration with the University of Zululand, a historically disadvantaged university in South Africa, relating to the use of astronomy for Physics teaching), and the One World Experiment (an effort to test, using more rigorous evaluation techniques, whether the perspective that astronomy gives would change a young person's empathy towards those from outside their normal groups).

7.3. *Liaison with IAU Divisions and Commissions in planning and implementing relevant programs.*

- This aspect has been significantly strengthened since the appointment of the **OAD Astronomer**. Through her efforts the OAD has established points of contact in all Divisions; coordinates a panel discussion with Division representatives at IAU General Assemblies; participates in Division/Commission meetings; sends out contributions to the relevant newsletters or communications from Divisions and Commissions.
- The OAD Director and Astronomer usually join and provide updates to the **IAU Executive Committee Meetings** which include all Division Presidents, prior to which a report is disseminated.
- Through the regular liaison with Divisions the OAD becomes involved in **specific programmes** of the Divisions/Commissions/Working Groups wherever possible e.g. AstroEDU, Network of Astronomy Schools Education, and the Young Astronomers Lunch programmes from Division C/Commission C1; the Communicating Astronomy with the Public conference and journal from Commission C2; the Gender Gap Survey from the Executive Committee Working Group on Women in Astronomy; the Inspiring Stars programme from the Executive Committee Working Group on Equity and Inclusion.

7.4. *Liaison with IAU Regional Offices of Astronomy for Development and IAU Language Expertise Centres in planning and implementing relevant programs.*

- **Regions:** The OAD coordinates 11 regional offices and language centres. Details on the regions can be found in 3.4 and Appendix A5. Global activities such as the call for proposals and flagship projects are implemented in close collaboration with the regions e.g. regions provide input into both stages of the call process, and are the main structure for implementing flagships globally.

7.5. *Liaison with other international unions and agencies such as ICSU Regional Offices, UNOOSA, COSPAR and URSI, in planning and implementing relevant programs.*

- The OAD regularly liaises with the **ISC¹⁹ and its Regional Office for Africa**. This culminated in a partnership to host an interdisciplinary Science for Development workshop in January 2020, which was attended by over 100 participants across a range of disciplines from 25 countries. The aim of the workshop was to bring together experts from both science and development fields, especially from across Africa, to stimulate collaborations/partnerships and generate ideas/plans for interdisciplinary science-for-development projects.

¹⁹ The International Council for Science (ISC) was formed through a merger of ICSU and the International Social Science Council (ISSC) in 2018: <http://council.science/>

- Liaison between the IAU and other bodies such as UNOOSA and COSPAR has been coordinated by the IAU General Secretary/Secretariat. The OAD has been included in various conversations or approached for input where necessary, e.g. on the Open Universe initiative, but has not been called upon to lead any of those interactions.
- The OAD has established an MOU with Space Generation Advisory Council (SGAC) which has Observer Status with the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). OAD Operations Manager Venugopal, as a member of SGAC, leads the interactions with the Space community and has attended events such as the International Astronautical Congress, the African Leadership Congress on Space Science and Technology for Sustainable Development, and Global Conference on Space for Emerging Countries GLEC 2019 (organised by the International Astronautical Federation)
- Govender served as a member of an OECD Expert Group on Socio-Economic Impact of Research Infrastructure. This opportunity came about through the close relationship with DSI.

7.6. *Liaison with other relevant IAU activities such as the Office for Astronomy Outreach (OAO) and the Office for Young Astronomers (OYA).*

- The OAD has always had a very close relationship with the **OAO** since its establishment in 2012 and continues to have regular meetings to synergise activities and networks. Communication is coordinated and shared so that there is not duplication of effort. Projects of common interest are developed through these interactions such as the Astronomy Translation Network, the OAD Volunteer Portal and a special edition of the CAP Journal on Astronomy for Development²⁰. The OAO also has a standing position on the OAD projects review panel. Venugopal currently serves on the organising committee of CAP conference. Since 2015 the OAO and OAD have had a joint exhibition space at the IAU General Assemblies.
- The OAD had previously worked closely with the International School for Young Astronomers (ISYA), so when the **OYA** was established in 2015 there was already an established relationship that maintained close interactions. For example, when the East African ISYA was held in 2017 the East African Regional Office of Astronomy for Development was one of the main hosts. At least one of the Steering Committee members of the OYA serves on the OAD projects review panel.
- Since the establishment of the **OAE** in 2019 the OAD has worked closely with them to ensure synergies, contributing to their planning process. The OAD had already had previous collaborations with hosts of the OAE (Haus der Astronomie) so this was a smooth transition.
- The 2020-2030 strategic plan clarifies the mandates of these four IAU offices and has enabled efficient collaboration between them. **Mechanisms to ensure synergy** have been put in place such as a regular monthly telecon, a standing meeting between the four offices and the IAU Officers; guaranteed “institutional sessions” for each office at IAU General Assemblies (similar to Focus Meetings); common exhibition areas at GAs; and coordinated communication. OAO, OYA and OAE representatives are on the OAD’s regions mailing list and are invited to all meetings of regions. An example of a common area of interest across all offices is translation, which the OAO has led through the Astronomy Translation Network, with input from OAD LOADs and ROADs.

7.7. *Liaison with large international astronomical facilities and projects, such as the Square Kilometre Array.*

- With regard to the **SKA**, the OAD has strong ties with especially the Africa part of the SKA:
 - OAD Astronomer McBride leads interactions with DARA (Development in Africa through Radio Astronomy) which targets primarily SKA Africa partner countries (OAD is represented on the DARA Steering Committee; we coordinate a special initiative for development projects in those countries; and currently host a DARA Big Data fellow at the OAD)

²⁰ Available online at <https://www.capjournal.org/issues/27/>

- The OAD is regularly represented at SKA Africa ministerial meetings where we provide updates on OAD activities in the African partner countries as well as relevant matters such as the IAU General Assembly in Cape Town in 2024 (first time in Africa).
- We have supported the SKA communications team on several projects such as a communications workshop in Ethiopia in 2017 (in parallel with the International School for Young Astronomers and the Middle East and Africa Regional IAU Meeting), and the community launch event for the MeerKAT telescope in 2018.
- We have worked closely with the African VLBI Network, which is seen as a preparatory project for SKA in Africa, sharing networks and attending each other's stakeholder meetings.
- The establishment of the African Astronomical Society in 2019 (technically a *re*-establishment since it was relatively dormant since 2011) was initiated through a meeting with the SAAO and SARAQ, and close liaison since. AfAS is now a strong, well-funded organisation, aiming to grow astronomy in Africa.
- The OAD has, both independently and in partnership with the SKA Project Office, supported the development of astronomy skills in SKA Africa partner countries. This synergy with SKA was enhanced with the establishment of a regional office in Zambia.
- McBride serves on SARAQ Users Committee, SARAQ Bursaries Conference SOC, and is part of SAAO research staff.
- Venugopal represented the OAD at the SKA Ministerial Meeting in Ghana as well as the launch of the new Ghana radio telescope and Radio Observatory, where he presented all the OAD projects in SKA partner countries.
- Regarding other large astronomical facilities, the OAD maintains very close ties with **SAAO and SARAQ** in South Africa, both due to convenience of location and shared ambitions for Africa. The OAD also liaises (mainly through its regional offices) with other international facilities, some of which actually host the OAD regional offices e.g. National Astronomical Research Institute of Thailand, Ethiopian Space Science and Technology Institute, Centre for Basic Space Science in Nigeria; European Astronomical Society and Leiden University in the Netherlands.
- The OAD has also worked closely with **other astronomical organisations** on specific projects such as the Royal Astronomical Society in the UK (mobility grants for development projects); the Inter-University Centre for Astronomy and Astrophysics in India (visitor programme and online tools for volunteers and projects); Associated Universities Incorporated (review of education activities, strategic input and exchange programme); the African Millimetre Telescope (astro-tourism in Namibia around the telescope); Kenyan Optical Observatory project (community development around the proposed observatory)

7.8. *Stimulation of communication on development matters between astronomers, IAU members and associated members, other relevant fields and interested parties through the maintenance of a website for development and education and appropriate forums.*

- The OAD has a **comprehensive website** that has been in place since 2011 (www.astro4dev.org). All information related to the OAD and astronomy-for-development is published on that website, which also serves as the port of call for our call for proposals application process, information on past projects, etc. Regional offices which do not have web space of their own have the option of using subdomains on the OAD website.
- The OAD issues **regular communications** via several channels including:
 - IAU announcements and press releases for newsworthy events²¹
 - Quarterly OAD newsletter
 - Annual “glossy” booklet on OAD activities (initially “yearbook”, now annual report)

²¹ Media releases can be viewed at <http://www.astro4dev.org/press-releases/>

- Regular social media posts, mainly on Facebook and Twitter²²
- Handout material such as a project highlights booklet, OAD information flyer, postcards.
- An OAD coffee table book (developed for the 2018 IAU General Assembly)²³
- The OAD also ensures that topics around astronomy-for-development are discussed at key **meetings and conferences**. The OAD has consistently hosted a special session or Focus Meeting at all IAU General Assemblies since its establishment. The OAD is represented at almost all IAU regional meetings such as MEARIM, LARIM and APRIM. We have participated in many other key meetings such as CAP, EWASS, AAS, ALC, SciFoo, ITCA, PCST, SciDataCon, ICRI, UN World Data Forum, World Science Forum, ISC Gender Gap Workshop, etc. Details available in regular reports.

7.9. *Proactive coordination and initiation of fundraising activities and partnerships for programs consistent with the goals of the Strategic Plan 2010-2020.*

- The OAD has three active partnerships in place with the following organisations where funding is involved (see full list of partners in Appendix A6 and a full summary of leveraged funds in Appendix A2):
 - Royal Astronomical Society (RAS): RAS provides mobility grant funding of **GBP10,000 per year** for development collaborations between Europe (primarily UK) and countries with less developed astronomical communities.
 - Development in Africa with Radio Astronomy (DARA): DARA provides funding of around **GBP5,000 each** for astronomy-for-development projects in AVN countries (Botswana, Kenya, Ghana, Madagascar, Mauritius, Mozambique, Namibia, South Africa and Zambia). OAD supports the call, proposal development training, and proposal review process.
 - DARA Big Data: Through a partnership with DARA Big Data, the OAD hosts a **postdoctoral fellow**, Dr Nikhita Madhanpall, who coordinates the implementation of “hackathons” across the AVN countries (estimated value around **GBP20,000** per year for two years)
- The OAD has received other specific funding over the review period including:
 - EU Space Awareness Project funding from the European Commission’s FP7 programme (Total of **ZAR873,577 over three years**): This three-year project, led by Leiden University with several partners across Europe, involved the development and dissemination of educational resources related to Astronomy and Space Science.
 - Funding for postdoctoral fellow Dr Wanda Diaz Merced from the NRF (Total of **ZAR915,000 over three years**): This was in support of the AstroSense project, initiated by Dr Diaz-Merced while she was still a Visiting Fellow at the OAD, on the subject of accessibility and inclusion in science. That project has now evolved into the Inspiring Stars programme under the IAU.
 - DSI funding of **R2,000,000 over two years** for the establishment of the African Astronomical Society (R1,000,000 for the Astronomy in Africa meeting in 2019 to establish AfAS; R1,000,000 operational funds for AfAS during 2019/2020). AfAS has since become an independent organisation, set up its own bank accounts, and received R6,485,000 for AfAS full operations during 2020/2021.
- The OAD has initiated partnerships around the **flagship projects** which will be the basis for fundraising initiatives:
 - The **Global Himalayan Expedition** was funded by the OAD, through the regular call for proposals, to establish the AstroStays programme. This programme trains and equips women in small villages in the Himalayas to use astronomy to stimulate tourism in the area. Given the success of the project and the potential for global “rollout” the OAD is looking at using this model in other parts of the world as part of the flagship on astronomy for socio-economic development.

²² OAD’s social media footprint can be gauged by visiting the respective Facebook and Twitter pages:

<https://www.facebook.com/astro4dev/> and <https://www.twitter.com/astro4dev>

²³ Electronic versions of materials (flyers, reports, etc) available at <http://www.astro4dev.org/downloads/>

- The **European ROAD** is coordinating a project called Pale Blue Dot, which is built on the foundations of the Universe Awareness Programme, and aims to use the perspective of astronomy and space to inspire a sense of global citizenship. The OAD will work with the European ROAD to raise funds and implement this idea under the flagship on astronomy for peace and diplomacy.
- The partnership with **DARA Big Data** involving the training of data science skills through hackathons, is being used to develop the flagship on astronomy knowledge and skills for development.
- **Other initiatives** over the review period include
 - A coordinated funding proposal to then ICSU with all OAD regional offices and language centres, in response to their call for proposals for inter-union projects (unsuccessful).
 - Drafting of a fundraising brochure.
 - Partnership with HSRC over the AstroSense project, in order to raise funds required for a joint research project on using astronomy for STEM education in schools for the blind.

7.10 *Management of OAD in terms of:*

- *leadership;*
 - The OAD leadership was recognised in 2016 through the award of the Edinburgh Medal “jointly to Kevin Govender and the IAU”. An invaluable part of this leadership has been the OAD Steering Committee, comprising excellent individuals who have brought a diversity of experience to the OAD. The first two Chairs of the OAD Steering Committee, George Miley and Khotso Mokhele, were particularly instrumental in establishing and shaping the OAD through their vision, guidance and wisdom. Khotso Mokhele in particular is a world-renowned leader and the OAD has been extremely fortunate to have him both as the longest serving Steering Committee member over the past decade, and a mentor to the OAD Director.
 - The OAD has always maintained an excellent reputation internationally and among its various stakeholders, most of whom have remained engaged with the OAD for the full decade of its existence. This would not be possible without strong leadership.
 - There is a diversity of contexts, cultures and challenges in the many different regions in which the OAD has established offices. It has been important to have strong leadership, both in terms of the Director and the OAD Steering Committee, to steer the OAD diplomatically and strategically through the challenges that have arisen along the way. The continued operation of those regional offices, in spite of the challenges faced, is testament to OAD leadership.
 - Leadership within the SAAO, NRF, DSI and IAU has been exceptional with regard to the OAD, primarily in terms of maintaining the strong support for the vision that went into the establishment of the initiative, but also in terms of providing advice and guidance wherever needed on day-to-day operations (such as local efforts with historically black universities in South Africa as well as global projects like Inspiring Stars).
- *staffing;*
 - The OAD has a small but excellent team that has been praised by all stakeholders who have interacted with them. Specifically, this team is known for its friendliness and efficiency in spite of the significant pressures that are sometimes placed on them due to the scale of its operations.
 - The OAD team has been able to keep the operations moving in spite of significant challenges faced such as visa issue with Venugopal and family health challenges with Govender. The team is able to support each other whenever needed to ensure that the OAD goals are accomplished.

- The staff of the OAD has evolved over the review period, with the current team²⁴ illustrated in the functional organogram in Figure 1. The experience of the OAD has shown the optimal structure of this small but effective team: a Director; an Astronomer; a Development specialist; an Operations Manager; an Administration Officer; and OAD Fellows to lead various key projects such as the OAD flagships. At the time of writing all these roles are currently fulfilled. **However, there is a need to formalise the role of the Development specialist in the longer term** (it is currently fulfilled by Development Economist Tawanda Chingozha who is on a short-term contract).
- *commitment of institution hosting the OAD;*
 - The OAD has received excellent support for its activities from the NRF, and specifically from the SAAO where the OAD is based. The OAD operates as a department within the SAAO and we enjoy a mutually beneficial relationship where SAAO provides the invaluable HR, Finance and IT support, while the OAD contributes to the SAAO management and activities wherever possible e.g. the OAD brought its experience of conflict management and facilitating regional discussions to assist with a staff-wide engagement on the inclusive development of an SAAO strategy. The OAD also brings international opportunities, resources and activities to the SALT Collateral Benefits Division of the SAAO, which is responsible for education, outreach and community development activities.
- *location of the OAD;*
 - The first decade of the OAD’s existence has taught us that the OAD is currently in an excellent location. Africa has remained a region in great need of development and the OAD’s current location on the continent, hosted within a world-class observatory, has opened up many opportunities for engagement with the pan-African astronomy community. The OAD’s location in Africa, and its efforts on the continent, have contributed to significant milestones for the continent such as the revival and strong establishment of the African Astronomical Society, and the successful bid to host the first IAU General Assembly on the African continent in 2024.
 - The location of the OAD in South Africa was a wise choice because the country has consistently shown itself, through its leadership right from government Ministerial level, to reflect the spirit and vision that lies at the heart of the OAD (then Minister of Science and Technology Naledi Pandor was awarded an Honorary Professorship on Astronomy for Development by Leiden University as well as the AAAS Award for Science Diplomacy).
 - The location of the OAD within the SAAO has been mutually beneficial, an opinion shared by the SAAO director (see also 8.2). Being within a world class observatory has meant direct access to the astronomy research community, which the OAD can call upon to engage in its activities. The dual-site location of the SAAO (in Cape Town and Sutherland) has allowed the OAD to attract international Fellows and visitors to one of the world’s most sought after cities to visit, while also exposing them to the challenges of a rural community in Sutherland, and exploring ways in which astronomy can influence livelihoods there.
 - In the decade-long existence of the OAD, and our experience and efforts in reaching out to virtually every corner of the planet, we don’t believe there is a better place to locate this global office. The visionary foresight of the founders of the OAD, who decided to locate the office here, are to be commended.

²⁴ Photos and bios available on the OAD website: <http://www.astro4dev.org/oadteam/>

- *funding;*
 - The OAD receives operational funding both from the South African Government as well as the IAU (See Appendix A1 for a summary of the contributions over the review period). It also manages the IAU project funding which is paid directly to successful grant-holders from the IAU headquarters in Paris (see Appendix A3). Operational funds are sent to the SAAO bank account and accessed via the OAD's cost centres. The financial years of the partners (NRF and IAU) are different (April to March and January to December respectively). All financial policies and procedures of the SAAO (NRF) are adhered to. The OAD's finances are audited along with the SAAO's audits.
 - Due to multi-year projects and the differing financial years of the contributing partners, OAD funding is managed such that all funds are utilised over the full period of the IAU-NRF agreement, as was done during the previous agreement period. Spending and budgets are presented to and approved by the OAD Steering Committee at its annual face-to-face meeting in Cape Town.
 - In terms of core funding vs leveraged funding, the OAD has managed to leverage more than it has cost the partners. The total OAD income from the IAU and NRF/DSI over the review period amounts to **R20,368,221 (~€1,420,387)**, while the total amount leveraged through partners, grants and regions amount to **R28,800,570 (~€2,008,422)**. See Appendices A1 and A2 for details.
 - The core funding has been adequate for the OAD's staffing and operations thus far, mainly due to underspends accumulated due to unfilled positions. However, there is a gap in staffing that has been identified (development specialist). We therefore recommend that **one additional full-time position** be funded.

- *strategic positioning of the OAD and future plans, particularly in relevance to the host country and the IAU broadly.*
 - During 2017 and 2018 the OAD engaged in a consultative process with its stakeholders to explore its strategy and future plans. This was stimulated by a broader initiative by the IAU to develop a new IAU strategy for the 2020-2030 decade. The OAD's detailed input was welcomed and captured in the IAU's 2020-2030 strategy, which was adopted at the 2018 IAU General Assembly in Vienna. See Section 9 on the Future of the OAD.
 - In terms of the relevance to the host country and the IAU, see Section 8 on benefits of the OAD to its primary stakeholders. In short, the OAD has successfully led a global effort to ensure that the field of astronomy delivers a tangible and meaningful benefit to society. This is very much in line with the visions of the host country, the host organisations and the IAU.
 - There have been several strategic projects, activities and partnerships that the OAD has engaged in, which are of particular relevance to the host country, including partnerships with DARA and DARA Big Data to support the SKA-Africa partner countries; involvement in the BRICS Astronomy initiative; participation in the Africa-Europe Radio Astronomy Platform; involvement in the IAU General Assembly 2024 (South Africa) National Organising Committee; facilitation and close ongoing involvement with the African Astronomical Society; OAD Director's role on and contributions to the SAAO Executive; OAD Astronomer's Adjunct Associate Professor Position at the University of Cape Town and her role in SAAO Research; AstroVarsity initiative to support growth of skills through astronomy at historically disadvantaged universities in South Africa; recent extraordinary call for COVID-19 related projects; etc. (see next section on Benefits)

8. Benefits of the OAD to primary stakeholders

The OAD, in fulfilling its mandate *in its current form and location*, brings benefit to all its stakeholders. Some of the more specific benefits that the OAD has brought to its primary stakeholders (IAU, NRF, SAAO, DSI), due to its current location and activities, are listed here.

8.1. Benefits to the IAU

- 8.1.1. **Relevance of astronomy:** The OAD is a visible demonstration to governments and communities across the world that astronomy is socially relevant and not purely a curiosity driven “blue skies” science for a few in ivory towers. The focus on using astronomy to address the UN Sustainable Development Goals enables all astronomers across the world to explain to their governments how this field can respond to national development goals, which generally align with the SDGs.
- 8.1.2. **Excellent partners:** The substantial investment in astronomy by the South African government, supported by high level policies and legislation, is motivated by the recognition that astronomy is an important tool for national and global development. The SALT Collateral Benefits Programme (SCBP) at SAAO is a model of deriving societal benefits from astronomy and astronomical observatories. The OAD has also used its location within a world class astronomical observatory to tap into the skills of SAAO astronomers and engineers for implementation of its activities, especially on the African continent.
- 8.1.3. **Development landscape:** South Africa is rich in development projects and expertise which has been tapped into by the OAD. The South African landscape is also a good testing ground for pilot projects, due to the diversity of its population. Africa remains an area of global focus for development funding and aid. The OAD’s placement on the African continent opens doors in international environments.
- 8.1.4. **Focus on Africa:** The IAU has had direct access to one of its development focus areas (“sub-Saharan Africa” according to the 2010-2020 strategic plan) with an increased participation in OAD activities from this region as compared to others. The OAD’s efforts in the region have led to the establishment of an African Astronomical Society, which meets other goals of the IAU, such as advancing astronomy across the world.
- 8.1.5. **Fundraising:** Support and advice from the South African government is always an important asset in fund raising campaigns, given that the country is often seen as a “gateway” to the African continent for funders.
- 8.1.6. **IAU General Assembly 2024:** The OAD’s location has enabled it to play a significant role in rallying the African community behind the successful bid for the first IAU General Assembly on the African continent in 2024.
- 8.1.7. **IAU Visibility and Reach:** The diversity of OAD projects, reaching over 100 countries, has helped to increase the IAU’s visibility. The establishment of 11 regional offices and language centres across the world means that the IAU has a solid footprint in all these regions, supporting its goals to serve the international community. This network has connected people with the IAU and even attracted new national members, especially in Africa
- 8.1.8. **Role in global challenges:** The OAD provides a space for astronomers to engage in how their field can be used to address global challenges. The OAD is also able to react quickly to global crises such as the COVID-19 pandemic, enabling the IAU and its membership, as well as the astronomy community at large, to contribute in a coordinated and meaningful way.
- 8.1.9. **Supporting other IAU Offices:** The OAD was the first of the IAU offices (followed by the OAO, OYA and OAE respectively). This has meant that the OAD has been able to advise and support each of the other offices as they were being established.

8.1.10. **Attracting young people:** The work of the OAD has attracted the attention of many young astronomers who are interested in participating in global causes, and who see the greater societal value that the IAU brings through the OAD.

8.2. Benefits to NRF (and SAAO)

- 8.2.1. **Societal impact:** A key part of the NRF vision is about the societal impact of science. The work of the OAD serves as an illustration of how the field of astronomy, which is one of South Africa's largest strategic investments in science, can and is having an impact on society, not only in this country, but globally. The hosting of the OAD positions the NRF as a global leader on "astronomy for development" or using science for societal impact.
- 8.2.2. **Transformation:** Through the OAD's AstroVarsity programme, astronomy is used to stimulate education and research at higher education institutions. By supporting Historically Black Universities (HBUs) in South Africa to develop their capacity and networks, the OAD speaks directly to the NRF's strategic goals around transformation.
- 8.2.3. **Research:** It is important for the OAD that McBride remains an active researcher. She continues to publish under SAAO affiliation and as an Adjunct Associate Professor at UCT. She teaches a course to a small MSc class and supervises postgrad students. As of 2020 she contributes to the SAAO Research Strategy through a part time Head of Research role.
- 8.2.4. **STEM Education:** Several OAD projects rely on the inspirational nature of astronomy for young people. The OAD funds and gathers resources about activities such as teacher training, curriculum development, resource development, star gazing camps and art competitions, to name a few. All these activities speak directly to the mandate of SAASTA (which lies within the NRF) as well as the Youth into Science Strategy of the DSI. The SAAO and the NRF Astronomy Cluster's education and outreach efforts are obvious beneficiaries from these networks, resources and projects.
- 8.2.5. **Science engagement:** A key component of the NRF is science engagement. The OAD, in synergy with the its sister office, the OAO, based in Japan, has helped to coordinate various science engagement initiatives such as Naming Exoplanets, and brings such opportunities to the South African community mainly through its collaboration with the SAAO's SCBP department. The OAD director has also served on various South African committees such as Scifest Africa's Advisory Committee; Quest Magazine's editorial board; and ASSAf's STEM Committee.
- 8.2.6. **Supporting SAAO's goals:** The OAD's networks across Africa have been used to achieve SAAO's goals of expanding its reach across the continent. The OAD has a close working relationship with the SAAO's SCBP including pilot activities for community development in Sutherland, "sharing" of international visitors, sharing of resources, piloting of projects at schools, etc. The OAD regularly hosts visitors who contribute to SAAO colloquia and events.
- 8.2.7. **Contributions to SAAO management and morale:** The OAD Director's position on the SAAO Executive brings perspectives based on the international experience of the OAD and the director himself, including conflict management and facilitation of strategic planning discussions among diverse groups. A more subtle but significant contribution of the OAD to the SAAO is that of staff morale and motivation. The OAD occasionally hosts informal events during coffee or lunch breaks during which time the inspirational activities of the OAD are presented. SAAO staff response to such events has been consistently very positive.
- 8.2.8. **IAU General Assembly 2024:** The OAD is represented on South Africa's IAU National Committee (which acts under the NRF) in an ex-officio position, and has been able to advise and support South Africa's initiatives such as the bid to host the IAU General Assembly in 2024. The OAD currently plays a key role in the National Organising Committee of that meeting, with McBride chairing the committee and Govender in charge of legacy aspects.

8.3. Benefits to DSI

- 8.3.1. **International reputation:** The decision of the IAU to locate its OAD in South Africa highlights the country's position as a global leader in the fields of astronomy and of "science for development". Having OAD activities coordinated from South Africa (including 3 flagship projects, 11 regional offices, 160 projects reaching over 100 countries, international partners, volunteers, etc) contributes to South Africa's, and DSI's strong international reputation. Any international achievements and prestige of the OAD (such as the Edinburgh Medal) are, and will be, linked to South Africa and specifically to the DSI. In 2018 an Honorary Professorship in Astronomy for Development was awarded to the then Minister of Science and Technology Naledi Pandor.
- 8.3.2. **Policy alignment:** The OAD's activities have always been aligned with the DSI's strategies and policies over of the 2010-2020 decade. These policies emphasise the societal impact of science, such as Human Capital Development. Moreover, the OAD's work speaks directly to the vision of the current 2019 White Paper on Science, Technology and Innovation, which has a clear focus on science for development. The OAD, through its experience, is also able to support specific strategic development initiatives of DSI such as astro-tourism.
- 8.3.3. **Transformation:** The various special/pilot projects coordinated by the OAD benefit the South African environment and fulfil the DSI's objectives in terms of human capital development and transformation. An example of such an activity is the introduction of astronomy at the Physics departments of historically black universities in South Africa and related support for the development of astronomy capacity at HBUs. Another example is the development and testing of astronomy resources for the visually impaired.
- 8.3.4. **Lobbying:** There is always keen interest in the OAD by DSI stakeholders and collaborators, which has shown itself through visits to the SAAO and OAD by the Parliamentary Portfolio Committee on Science and Technology, the European Union Director General of Research and Innovation and the Executive Director of The World Academy of Sciences (TWAS), to name a few. The OAD has also been part of the DSI's Africa-Europe Radio Astronomy Platform (AERAP) and has helped facilitate conversations around Africa-Europe partnerships in astronomy e.g. through meetings of the European Astronomical Society.
- 8.3.5. **Astronomy in Africa:** The OAD facilitates interactions between South African astronomers and those in other parts of Africa – which profiles and enhances South Africa's role in developing astronomy in Africa. A highlight of this was the OAD's facilitation in creating the African Astronomical Society, which is supported by DSI and is now a key player in DSI's Africa-wide astronomy initiatives. The OAD has also sought ways to take the benefit of the SKA to other (non-partner) African countries. This has shown to be an important role strategically, as some are quick to point out that the whole African Union put its support behind the DSI bid to host the SKA in Africa. Thus, questions sometimes arise from other African (non-partner) countries in terms of the societal benefits of astronomy in their countries.
- 8.3.6. **International collaborations:** The OAD brings to South Africa opportunities for numerous international projects and collaborations through its global networks. Since the OAD operates and collaborates within the South African science and technology system, there are times when DSI is invited to OAD-related events (such as the OAD-ISCROA Science for Development Workshop, IAU General Assembly, meeting of regions, etc) and vice versa (such as the International Conference on Research Infrastructures, BRICS astronomy workshops, various bilateral meetings, etc). Govender also represented DSI on the OECD Expert Group on Socio-Economic Impact of Research Infrastructure. These close synergies have been a feature of having the OAD in SA.
- 8.3.7. **Opportunities for young professionals:** A growth of OAD activity creates opportunities for young professionals in South Africa, and, through the OAD's internship and fellowship

programmes, helps to expose young scientists in South Africa to international collaborative activities. Many of the young scientists who pass through the OAD have a passion for development and wish to explore ways to apply their scientific training for societal benefit – the OAD provides an important space for this.

- 8.3.8. **IAU General Assembly 2024:** The DSI had a specific strategic interest in hosting the world’s largest international astronomy meeting, and the OAD worked with the South African team in order to achieve a successful bid for this meeting. As mentioned before, the OAD currently plays a key role in the National Organising Committee of that meeting, with McBride chairing the committee and Govender in charge of legacy aspects.

9. Future of the OAD

- 9.1. Sustainability:** The future of the OAD (as a concept) has been codified into the IAU’s 2020-2030 Strategic Plan, which is an expression of the commitment of the IAU to continue to supporting the OAD (as an office) through the next decade. The partnership between the IAU and the South African government has created an excellent environment for the OAD to thrive in order to meet and sometimes exceed the expectations of its founders and its principals. South Africa’s intentions to maintain a strong relationship with the IAU is clear in its commitment to host the 2024 IAU General Assembly in South Africa – this would be the first on the African continent and South Africa has taken a leadership role in bringing together the continent around astronomy (such as its hosting of the African Astronomical Society, which the OAD remains closely involved with). However, the future of the OAD in its current form (as an office hosted in South Africa) would depend on the outcome of this 2020 review and a recommitment from all partners to continuing the OAD into the next decade.
- 9.2. Global Context:** When reflecting on the future of the OAD, one has to consider the question of what the world will look like in the 2020-2030 decade. Already the **COVID-19 pandemic** has completely shaken the status quo globally, and we find ourselves talking about a “new normal” where travel restrictions and social distancing become a way of life. This pandemic will leave a destructive socio-economic legacy that will be felt for years to come, with numerous sectors of business and leisure being hard hit or closing down completely. It has also created opportunities for other sectors such as online businesses and virtual conferencing. Prior to the pandemic one of the key topics on the lips of governments across the world was the “**fourth industrial revolution**”. In a way, the rapid move to online activity in the era of COVID-19 spurs such technological developments on. At the same time the **changing global climate** has not ceased to be a major concern. The unprecedented reduction in travel and economic activity during lockdowns in all parts of the world has meant a positive impact on the climate, with major cities reporting cleaner air, cleaner rivers, and thriving wildlife. However, an assessment of the impact on emissions²⁵ has shown that even these drastic reductions in emissions during COVID-19 confinement and restrictions, will only result in a minor effect, and that such levels would have to be sustained for much longer in order to positively influence our currently gloomy environmental trajectory. What role should the future OAD should play in this global context?
- 9.3. Elements of the future OAD:** Amid all the above societal changes and challenges, both current and imminent, the OAD has found its place in contributing to a better world, through leveraging all aspects of astronomy. The following are the key elements of the future OAD, informed from its decade of experience thus far and with input from its various stakeholders:

²⁵ Article in Nature Climate Change: <https://www.nature.com/articles/s41558-020-0797-x>

- 9.3.1. ***SDG focused:*** The OAD will remain firmly focused on SDGs, which have a target of 2030. An obvious question is why not choose a few SDGs and focus on them e.g. education. It is because the world is diverse and challenges facing humanity are diverse. Astronomy’s straddling of technology, science and culture means that there is much potential for impact across several SDGs. The community that engages with astronomy is also broad, including amateur astronomers who have a significant amount of diverse non-astronomy professional skills. Because of the inevitable yet unpredictable changes foreseen in the next decade, the OAD must remain pragmatic and allow for the possibility that astronomy’s impact on development could come from unanticipated areas.
- 9.3.2. ***Mix of top down and bottom up:*** The 2010-2020 strategic plan stressed a “bottom up” approach. However, it has become clear that a purely bottom up approach would not achieve the level of quality and scalability of strategic projects that is needed for development. The OAD would thus need a mix of “top down” (where guidance is given regarding needs and gaps) and “bottom up” (where the community provides guidance on what is needed locally).
- 9.3.3. ***Interdisciplinarity:*** We have learned that without cross disciplinary conversation, not only within the natural sciences but also the social sciences and development organisations, the idea of astronomy for development will not be fully realised. The OAD will ensure that working across disciplines is a key feature, using the attractive field of astronomy to bring other disciplines into the conversation. Other communities may include, but are not limited to, other natural sciences (especially Physics); the Space sector; various branches of social sciences; relevant industries and NGOs; art and cultural organisations; and other “4dev” initiatives such as ICT for Development, Data for Development, Machine Learning for Development, etc.
- 9.3.4. ***Astronomers for development:*** The OAD will aim to further engage with astronomers and other related professionals from the perspective of “borrowing” their skills e.g. apply astronomy data skills/computing resources to population data. The OAD will also aim to provide customized education and training for astronomers on development matters, in order to better enable the application of their skills to development challenges, or prepare them for potential careers beyond astronomy.
- 9.3.5. ***Embracing the 4th Industrial Revolution:*** The astronomy field continues to push the limits of technology both in terms of instrumentation (including precision engineering, large infrastructures, systems engineering, etc) and data (including large data sets, machine learning, data analytics and visualisation, etc). The OAD must engage with this important potential of astronomy to influence a society in the midst of the 4th industrial revolution, which may be accelerated through the COVID-19 pandemic. Importantly, the potential of astronomy to stimulate data science skills development, and to engage with initiatives involving development data, needs to be leveraged.
- 9.3.6. ***Contributing to “science for development”:*** The OAD will aim to contribute significantly to the global conversations within ISC and other relevant structures around “science for development”. This may include issues such as the communication of the importance of science; science diplomacy; applying critical thinking skills to issues of misinformation; etc.
- 9.3.7. ***Striving for impact:*** The OAD has already learned a lot in terms of how projects need to be shaped in order to ensure maximum impact. The impact cycle (see Appendix A4) provides the framework for projects to realise their full potential. The OAD should further develop this and educate the astronomy community on its meaning and resources. It should also be used to attract expertise from outside the astronomy field such as those in evaluation methodology and behavioural science. This will be a key component of OAD projects in the next decade.
- 9.3.8. ***Service to astronomy community:*** The OAD could potentially serve the astronomy and other communities in several ways. For big astronomy infrastructure projects, for example, there is often a need to provide additional justification on the societal benefits of such infrastructure, or formulate ways in which such infrastructure impacts local communities. For smaller projects, endorsement from the OAD (in the form of a label of “recommended project” - which arises out

of the call for proposals process) could help leverage funding for activities within the astronomy community. For the astronomy outreach community, there is a need to enhance outreach by determining what works and what doesn't work. Similar needs apply to astronomy education. Here the OAD could support the work of the OAO, OAE and OYA by providing support with project monitoring and evaluation guidelines. These and other synergies between the OAD and others within the astronomy community are essential.

- 9.3.9. **Research:** In 2016 the OAD hosted its first postdoctoral researcher (Dr. Wanda Diaz-Merced) with funding from the NRF. It is envisaged that more such research positions will be hosted at the OAD including researchers from other disciplines. There is clearly a wealth of information within the OAD's activities that could form the basis of research in many fields including international relations, social sciences, science diplomacy, impact evaluation, etc. Such research activity will strengthen the OAD's position as an interdisciplinary workspace.
- 9.3.10. **Fundraising:** The OAD, with the IAU and the IAU fundraiser, should engage in fundraising both for its own activities and for the community at large, with the latter being more of a support function than something the OAD leads. For its own activities the OAD, with the IAU and the IAU fundraiser, would need to approach individuals and organisations from outside the typical pool of astronomy funders, including those who fund development activities. Although this was already part of the initial strategic plan, we found that the language of that plan did not necessarily resonate with development funders. With a renewed clear mandate and easily understandable link to SDGs, this avenue can be better pursued in the next decade. To support the astronomy community at large, the OAD can help with lobbying and high-level fundraising efforts such as providing justification for governmental and other investment in astronomy.
- 9.3.11. **Responsiveness to crises:** The current COVID-19 pandemic has demonstrated the importance of the OAD to remain agile and flexible in order to respond quickly and decisively to crises. When infection rates rose and lockdowns began across the world, the OAD was able to use its call-for-proposals machinery to issue an extraordinary, rapid-turnaround call-for-proposals related to addressing the challenges created by the pandemic. The world is bound to be faced with other crises in the coming decade, and the OAD needs to be able to respond accordingly. There are also longer-term crises of course, that the OAD needs to respond to, such as climate change. Although climate change is a part of the SDGs, there is a need for specific focused effort, given the scale of the challenge and the short-term effects such as more frequent natural disasters.
- 9.4. Goals for 2020-2030 decade:** The OAD's goals for the next decade have been deliberated upon, and captured in the IAU Strategic Plan 2020-2030. The overall IAU strategic goal that relates to the OAD is Goal 3 of 5: *"The IAU promotes the use of astronomy as a tool for development in every country."* Specific actions for the OAD for the decade 2020-2030 are captured on Page 35 of that strategy as follows:
- *Contribute significantly to at least half of all SDG indicators; develop a number of global OAD "signature" projects.*
 - *Establish enough regional offices to cover all populated regions of the world.*
 - *Refine the OAD project evaluation and feedback loop.*
 - *Use astronomy and its technology to position young people for career opportunities throughout society.*
 - *Establish interdisciplinary partnerships around science for development.*
 - *Source the necessary funding to realise the above and assist other related initiatives in fundraising.*

10. Conclusion and recommendations

The OAD has successfully fulfilled its mandate for the 2010-2020 decade and is well positioned to continue to deliver on its goals for the 2020-2030 decade. It has operated cost-effectively to deliver on its global mandate, providing benefits to its key stakeholders, with a modest team and budget. There have been several challenges along the way, which the OAD has reasonably dealt with, and there have been several achievements, which the OAD and its team (both in Cape Town and across the world) can be proud of. This moment marks the end of a decade of effort to take an ambitious vision adopted in 2009 and build a structure around it that is now solid, far reaching and efficient. Important lessons have shaped the OAD over this first decade, and it is now well positioned to achieve a significant impact on global development over the next decade. From our experience within the OAD and taking into consideration Section 9 on Future of OAD, we would make the following specific recommendations:

- 10.1. Staffing:** It is clear to us that the current structure of a small (lean) coordinating office in Cape Town, and several regional offices around the world, should remain in place. OAD fellows, short term contract positions, and volunteers would then provide any additional support as necessary. Importantly, the OAD core staffing structure should have complementary astronomy and development expertise. Therefore, in addition to the current core staff of four (Director, Astronomer, Operations Manager, Administration Officer), we recommend that a fifth position be created for a development specialist, such as a Development Economist. We specifically mention a Development Economist due to both their overall understanding of the development environment, as well as their training in impact evaluation, which is important for the planning and assessment of impact of OAD projects. This position will provide the important balance between astronomy and development, which the OAD has currently achieved only through short term contracts and fellowships.

Recommendation #1: *Increase the current core staffing of the OAD from four to five, with one new position for a development specialist.*

- 10.2. Location:** The location of the OAD in South Africa has been extremely valuable with strong high-level support from the government. Its current location at the SAAO (NRF) in Cape Town, South Africa, can be credited with much of the OAD's success over the 2010-2020 decade. This is not only due to the synergistic visions of the partners, but also the logistics that make efficient operations possible. The OAD has been able to learn and negotiate the administrative landscape within the South African legislative framework (along with NRF and SAAO policies and procedures) in order to allow for efficient operation of this global initiative. The location has also enabled the OAD to attract and retain an excellent core team, as well as fellows and volunteers from around the world. Even the physical office space has been adapted to suit OAD operations. There is much about the spirit and achievements of the OAD that is fundamentally tied to its current location. The fact that the IAU General Assembly in 2024 will take place in Cape Town is another strong reason to maintain the current location of the OAD.

Recommendation #2: *Maintain the current location of the OAD.*

- 10.3. IAU-NRF Agreement:** The current IAU-NRF agreement is for 6 years (2015-2021), spanning two triennia or periods between IAU General Assemblies (IAU GAs are held every triennium – the agreement starts at one GA and ends two GAs later). We believe that the OAD has fulfilled the objectives of the agreement and that both the IAU and the NRF have benefited from it (see Section 8 on Benefits). The current agreement was modified from the previous one to articulate a clearer structure and terms of reference for the OAD Steering Committee, and to ensure regular

high-level meetings of principals. We believe this oversight structure, as well as the alignment of the agreement with two GA periods, has worked really well. Other than recommending a renewal, we have no substantive changes suggested for the future agreement.

Recommendation #3: *The IAU-NRF agreement should be renewed for a further 6 years (the period from the 2021 to the 2027 IAU General Assembly).*

- 10.4. Sustainability:** In order to achieve the 2020-2030 decadal goals of the OAD and to assure the global astronomy-for-development community of the stability and continuity of the OAD, there should be a statement of commitment from the partners about the continuation of their support for the OAD over this full decadal period. Such a commitment would naturally be tied to the outcome of regular reviews such as this one, as well as the approval of budgets, which normally only take place in three-year cycles. However, a commitment in principle for the continuation of the OAD in South Africa over the next decade would help immensely in terms of stakeholder management, staff retention, fundraising, long-term project planning, etc.

Recommendation #4: *IAU, NRF and DSI should agree in principle to supporting the OAD at its current location until 2030, subject to regular reviews and availability of funding.*

11. Acknowledgements

The OAD has been privileged to work with an incredible mix of people from across the world, who have all contributed to what the OAD is and what it has achieved. We are deeply grateful to the founders of the OAD (Bob Williams, George Miley, Ian Corbett); the founding Steering Committee members (Claude Carignan, George Miley, Kaz Sekiguchi, Khotso Mokhele, Megan Donahue, Patricia Whitelock); other Steering Committee members since then (Ajit Kembhavi, Bernie Fanaroff, Daniela Lazzaro, Ian Robson, José Miguel Rodriguez Espinosa, Katrien Kolenberg, Renée Kraan-Korteweg, Saalih Allie, Teresa Lago); IAU Officers over the decade not already mentioned above (Debra Elmegeen, Ewine van Dieshock, Norio Kaifu, Piero Benvenuti, Silvia Torres Piembert, Thierry Montmerle); SAAO Directors (Phil Charles, Ted Williams, Petri Vaisanen) and all the SAAO staff who have provided incredible support to the OAD over the years (Anthony Mietas, Glenda Snowball, Iriwaan Simon, Linda Tobin, Sivuyile Manxoyi, and so many more); NRF leadership (Albert van Jaarsveld, Clifford Nxomani, Gatsha Mazithulela, Molapo Qobela, Nithaya Chetty, Yunus Manjoo); DSI leadership (Daan du Doit, Mathoto Thaoge, Phil Mjwara, Takalani Nemaungani); the 2015 Review Panel (George Ellis, Jocelyn Bell Burnell, Ron Ekers); chairs of Task Forces (Carolina Ödman, Ed Gomez, Ed Guinan, Ian Robson, Pedro Russo, Michelle Gerbaldi) as well as all the task force members, later reviewers, over the years; past OAD staff (Elizabeth Grant, Jean-Christophe Mauduit, Wanda Diaz-Merced) as well as the many OAD team members who have spent time in Cape Town.

We are also deeply grateful to our regional coordinators and the many people involved in the establishment and operation of the regional offices and language centres, who are too many to mention by name but who have been essential in achieving OAD goals. Of course, we cannot achieve impact without the many project leaders and volunteers that have helped give on-the-ground meaning to astronomy-for-development across the world, and we are extremely grateful to each one of them.

Above all, the OAD would not be what it is without an incredible team in Cape Town, who have consistently gone above and beyond in their duties and service to this global community – the core team of Nuhaah Solomon, Ramasamy Venugopal and Vanessa McBride, and our current OAD Fellows Amidou Sorgho, Marie Korsaga, Nikhita Madhanpall and Tawanda Chingozha.

Appendix

A1. Core Funding

The OAD operates within the financial systems and policies of the NRF, which comply with South African national legislation. Compliance of the OAD's financial transactions to the relevant policies is tested through annual audits of the SAAO and NRF. The OAD financial year (April to March) is different as compared to the implementation of funded projects (calendar year), and long-term special projects or grants (which can be multi-year). Since 2016, the project grants (Appendix A3) are paid directly from the IAU in Paris (€110,000 per year, with a reduction to €90,000²⁶ for 2021 projects).

For the duration of the IAU-NRF agreement the OAD receives an annual core income from the DSI/NRF and the IAU, all administered through the NRF. For the first 5 years of the OAD (2011-2015) the DSI/NRF provided a fixed R1,500,000 per year and the IAU a fixed €50,000 per year. Based on the positive external review in 2015, and the renewed IAU-NRF agreement in 2015, the DSI/NRF then provided the R1,500,000 per year but with an annual inflationary increase of 6%, plus the salary and associated costs of a full time OAD astronomer. The IAU also increased its annual fixed amount to €70,000 per year, and additionally committed to funding a part time fundraiser.

Table 1: Summary of IAU and DSI/NRF contributions over the review period (in ZAR):

	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	Total
DSI/NRF (ZAR)	1,500,000	1,500,000	2,590,000	2,717,000	2,900,000	3,100,000	14,307,000
IAU (ZAR)²⁷	720,050	888,647	1,011,083	1,123,255	1,185,254	1,132,932	6,061,221
Total income (ZAR)	2,220,050	2,388,647	3,601,083	3,840,255	4,085,254	4,232,932	20,368,221
Expenditure (ZAR)	2,512,887	3,084,641	2,872,292	3,109,868	3,463,123	4,209,649	19,252,460
Surplus/Deficit (ZAR)	-292,837	-695,994	728,791	730,387	622,131	23,283	1,115,761

Over the full 6-year review period, the OAD received core funding, from DSI/NRF and IAU, totalling **R20,368,221** (~€1,420,387)²⁸. Over the same period the total expenditure was **R19,252,460** (~€1,342,579). The details of OAD expenditure for each year with explanatory notes can be found in the OAD business plan, which is presented to the OAD Steering Committee each year for approval. The total surplus of **R1,115,761** (~€77,808) was due to several factors including: (i) late appointment of Vanessa McBride in the new OAD astronomer position (budgeted for start in April 2016 but it was only filled in January 2017); (ii) Elizabeth Grant's salary during the unpaid part of her maternity leave and her unfilled position following her resignation in September 2017; (iii) delay in Ramasamy Venugopal's appointment due to visa challenges (see Section 5.1); (iv) costs for activities that were deferred or cancelled during the periods of unfilled positions. In our long-term budget projections until 2021 (when the OAD contract expires) we take this into account and our activities have been adjusted to redirect the surplus to the Development Economist Fellowship, COVID-19 related projects, and Flagship projects. All funds will be fully utilised by the end of the contract, as has been discussed with the OAD Steering Committee.

²⁶ Our understanding is that there is an expectation that the IAU fundraiser would essentially fill the gap

²⁷ This is the actual amount in ZAR that was received in South Africa based on the exchange rate at the time

²⁸ Using 10-year average of EUR to ZAR: 14.3399 (1 EUR = 14.3399 ZAR) – see Appendix A2.

A2. Leveraged funding

There have been funds leveraged through the years by the OAD. These have been mainly in the form of partnerships with organisations or funds leveraged by the regional offices. Smaller amounts of funds are leveraged by the OAD team, for example, when a host covers either flight or accommodation costs for a particular trip, but those details are not always costed (since such costs are usually borne directly by the hosts) and are therefore not included here. Tables 2 and 3 summarise the funds leveraged during this review period from partners, and by the regional offices/language centres respectively.

Table 2: Funds leveraged through partners during the review period (\$=USD; £=GBP; €=EUR; R=ZAR)

Source of funds	Period	Amount	Description/Comment
Netherlands Organisation for Scientific Research (NWO)	2015	€2,000	This was the last grant from the NWO-OAD agreement signed in 2012 for 3 years to provide mobility funds of up to €6,000 per year .
Royal Astronomical Society	Since 2017, ongoing	£23,867	RAS provides mobility grant funding of £10,000 per year for development collaborations between Europe (primarily UK) and countries with less developed astronomical communities. The full allocation was not utilised (£4,160 in 2017; £11,227 in 2018; £4,479 in 2019; £4,001 in 2020)
Development in Africa with Radio Astronomy (DARA)	Since 2018, ongoing	£51,797	DARA provides funding of around £5,000 each for astronomy-for-development projects in each of the SKA-Africa partner countries. However, only good proposals are accepted. £34,500 was awarded in 2018, and £17,297 in 2019.
DARA big data	2020-2021	£40,000	DARA Big Data provides around £20,000 per year for two years for the OAD to host a postdoctoral fellow, who coordinates the development and implementation of “hackathons” across the AVN countries
DSI (for African Astronomical Society)	2018-2021	R2,000,000	Funding for the African Astronomical Society (which the OAD was instrumental in setting up) was provided by DSI to the OAD, including R1,000,000 for the Astronomy in Africa meeting in the 2018/2019 year to establish AfAS, and R1,000,000 operational funds for AfAS during 2019/2020. Once established, AfAS was directly allocated R6,485,000 for its operations during 2020/2021 year, so is not included here.
European Commission (EU Space Awareness)	2015-2018	R873,577	OAD was a partner in EU Space Awareness (an FP7 Project with total value of €2,000,000 over three-years), led by Leiden University with several partners across Europe. The amount is the OAD’s share, reflected in ZAR since it was received onto the OAD books to be spent from Cape Town.
NRF (for Diaz-Merced postdoc)	2016-2019	R915,000	Funding from the NRF for postdoctoral fellow in support of the AstroSense project, on the subject of accessibility and inclusion in science (R305,000 per year)

Table 3: Funds leveraged by OAD Regional Offices and Language Centres during the review period (\$=USD; £=GBP; €=EUR; R=ZAR)

Region	Amount	Description/Comment
South West and Central Asia (Armenia)	€73,150	This is the total amount for the 2015-2020 period including salaries (AMD 4,110,000 equivalent to €7830), projects and events (€34,000), plus various travel grants obtained.
East Asia and Chinese Language	Unable to provide number	Staff time is provided in kind. 0.5 FTEs contractually agreed with both Beijing Planetarium and Yunnan Astronomical Observatory, all other staff members contribute their time voluntarily. Since EA-ROAD/LOAD is not an officially recognized organization in the Chinese system, they are not able to bring in funds. Currently trying to integrate EA-ROAD/EA-LOAD into the Chinese system.
Andean Region of South America	\$75,000	This comprises an estimate of people's time (\$25,000), and fundraising for the schools and meetings hosted (\$50,000).
East Africa	€348,783	This is over a 5-year period (2014-2019) and includes annual funding for the ROAD office from the Ethiopian government (€202,683); Travel and/or Subsistence for workshop participation and hosting guests (€66,100); hosting of workshops/events (€26,000); cost of individuals' and experts' time contributions (€54,000)
Arab World and Arabic Language	€10,900	This is over a 3-year period (2019-2021) and the main source of the funding was from the Arab Union for Astronomy and Space Science and the Regional Centre for Space Science and Technology Education.
Portuguese Speaking Countries	€119,950	This amount covers the period 2016-2020 and includes staff costs, partners' support, resources, grants and fundraising.
Europe	€265,277	This is for the period since its establishment in 2018 and includes general operational funds raised from Leiden+ASTRON+NOVA (€50,000); funds raised for specific projects (€29,875); an estimate of in-kind contributions in terms of people's time based on Leiden average full-time salaries (€91,350); and a recent Erasmus+ grant of €94,052 which was in partnership with four other ROADs.
West Africa	€65,556	This is for the period 2015 to 2019 and comprises contributions for salaries and events from the National Space Research and Development (NASRDA) Centre for Basic Space Sciences, and other fundraising for specific projects and activities.
South East Asia	€296,000	This amount includes operational funding both actual and committed for the period 2014 to 2021, from the National Astronomical Institute of Thailand, which is sole source of income.
North America	\$348,274	This office was established towards the end of the review period (January 2020) so this amount represents the budgeted commitments for 2020 (\$171,160) and 2021 (\$177,114) for salaries, benefits and travel.
Southern Africa	€97,500	This is for the period 2014 to 2019 and comprises project grants (€40,100), travel grants (€30,600) and training workshops (€26,800).

Consolidating the currencies of Leveraged funds:

Table 2 (Partners) totals in the different currencies = €2,000 + £115,664 + R3,788,577

Table 3 (Regions) totals in the different currencies = €1,253,972 + \$423,274

In order to estimate the total amounts in a single currency we use the 10-year average exchange rates²⁹ and compare all other currencies to the EURO (the majority currency above):

10-year average EUR to ZAR: 14.3399 (1 EUR = 14.3399 ZAR)

10-year average EUR to USD: 1.208 (1 EUR = 1.208 USD)

10-year average EUR to GBP: 0.839 (1 EUR = 0.839 GBP)

Using these rates the “single currency” totals are as follows:

Funds leveraged through Partners (Table 2) = €404,058

Funds leveraged through Regions (Table 3) = €1,604,364

Therefore, total funds leveraged through Partners and Regions = €2,008,422

Using the 10-year average between EUR and ZAR, this amounts to R28,800,570

A3. OAD Call for Proposals

Since 2012 the OAD has administered an open annual call for proposals³⁰ to attract projects related to Astronomy for Development. The call was initially separated into three focus areas and proposals were reviewed by the respective Task Forces: (i) Universities and Research; (ii) Children and Schools; and (iii) Public. The current situation is that we have a single large panel of reviewers, containing skills/experience in both astronomy and development, who score the proposals based on published selection criteria. These criteria are clearly mapped to questions on the proposal application form. An oversight panel considers the reviewers’ rankings and makes final recommendations in consultation with the reviewers. Proposers may request translation support during both Stage 1 and 2, which we provide with the help of regional offices, language centres and the IAU Translation Network. Translation requests received over the years included Arabic, French, Mandarin, Portuguese, Russian, Spanish, and Xhosa/Zulu.

Calls are issued around the middle of one calendar year for projects to be implemented in the next calendar year. The first three calls (2012-2014) were single stage calls. The next two (2015 and 2016) included an optional Expression of Interest (EoI) stage where projects had the opportunity to submit a brief EoI and obtain feedback from the OAD before completing a full proposal. This was in order to help improve the quality of project proposals and encourage more collaborative projects. In 2017 there was a further evolution to the call process, based on the EoI experience, to have a two-stage call, which is still in place today. Stage 1 now comprises a short basic proposal and is issued earlier in the year (around May). Only a limited number of those proposals are then invited to submit a more detailed Stage 2 proposal. Regional offices are also each allowed to nominate one proposal to proceed to Stage 2. Then, the OAD and its collaborators work with Stage 2 proposers and suggest modifications, improvements, partnerships, etc. before their Stage 2 proposal is finally submitted to the reviewers. This allows for engagement with project leaders before the allocation of funding, so the OAD can thus ensure that projects are both of a higher quality and have a greater potential for impact. All project proposers in both stages are provided with feedback from the reviewers. The final recommendations from the reviewers, along with the OAD’s report on the call process for that specific year, are presented to and

²⁹ from <https://www.ofx.com/en-au/forex-news/historical-exchange-rates/yearly-average-rates/>

³⁰ Webpage for the latest on the call for proposals: <http://www.astro4dev.org/cfp>

approved by the OAD Steering Committee around November, with grant agreements and grant payments taking place around December and January respectively. Those projects which are considered good, but which are beyond our limited budget, are placed on the OAD website as “recommended” projects, with the hope that other organisations or volunteers could support them.

Types of projects funded have ranged from using astronomy tourism to stimulate rural livelihoods in Himalayan villages in India; to tapping into the inspiring potential of astronomy to promote peace, mutual understanding and a sense of global citizenship in refugee camps in Algeria; to using astronomy to motivate students in Rio de Janeiro’s City of God and Gardenia Azul favelas in Brazil. To get a better idea of the types of projects we support, readers are encouraged to browse through the OAD website which has project overviews, photos, summaries and reports. Several “glossy” resources have also been produced to highlight a few interesting projects³¹. The map below (Figure 2) is a snapshot from the OAD website of all the projects funded through this call (160 projects targeting over 100 countries).

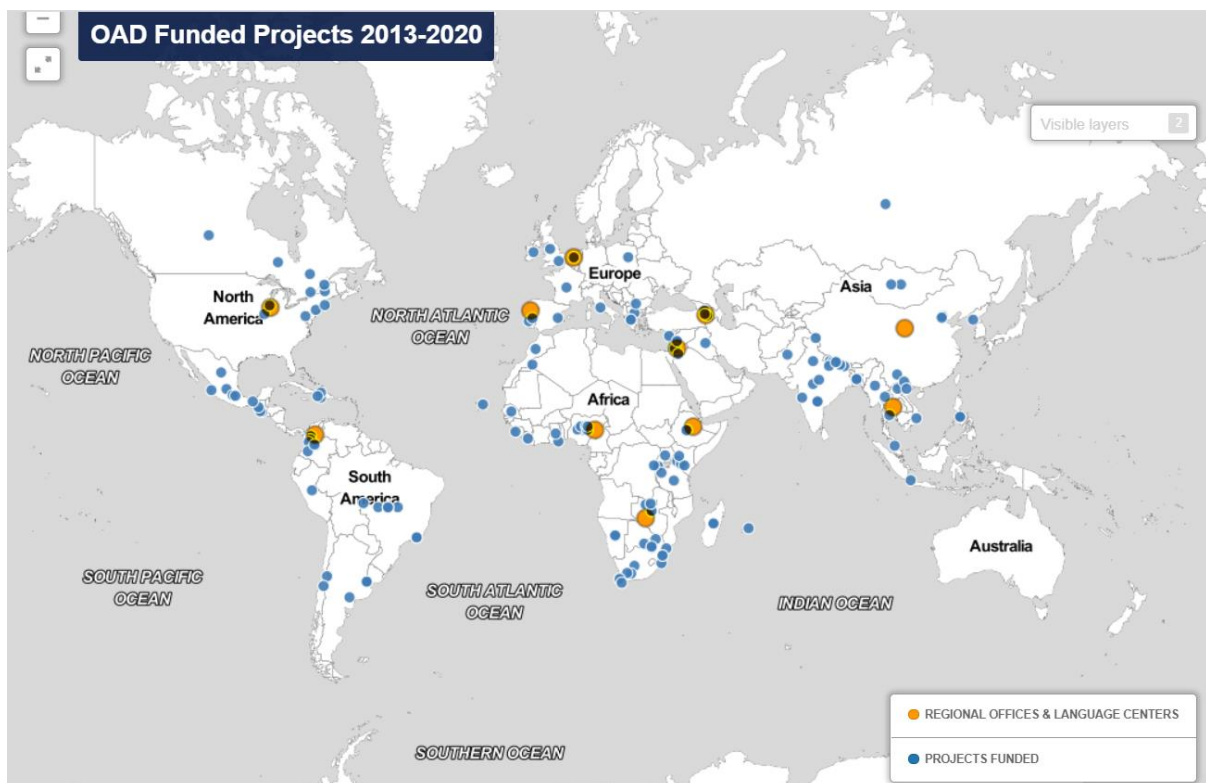


Figure 2: Geographic distribution of OAD funded projects

In 2019, the call process introduced themes (based on the recommendation of the Steering Committee) based on two Flagships (socio-economic development using astronomy and astronomy for humanity). In 2020 the third flagship theme was introduced to the call, on using astronomical knowledge and skills for development. Lessons, reports and resources from funded projects are publicly accessible in order to enable future projects to learn from and build on them (in particular a searchable resources database for OAD projects has been put in place with our partners IUCAA³²). Future project leaders are also provided with extensive guidelines including the OAD’s online course for proposers of astronomy-for-development projects³³. Table 4 below provides a summary of the statistics (including funding) of all the calls conducted over the full life of the OAD.

³¹ All “glossy” resources produced to highlight specific projects can be downloaded at <http://www.astro4dev.org/downloads/>.

³² See <http://www.astro4dev.org/oad-project-resources/>

³³ Guidelines and a link to the online course can be found at <http://www.astro4dev.org/getting-started/>

Table 4: Summary of the statistics over all the calls-for-proposals.

	2012 Call	2013 Call	2014 Call	2015 Call	2016 Call	2017 Call	2018 Call	2019 Call	Totals
Call released:	8 August	1 July	30 June	30 June	30 June	Stage 1: 28 Apr Stage 2: 04 July	Stage 1: 1 May Stage 2: 16 July	Stage 1: 22 April Stage 2: 25 July	
Call closed (deadline):	30 Sept TF1: 15 Oct	31 August	31 August	EoI: 15 July Call: 15 Sept	EoI: 15 July Call: 15 Sept	Stage 1: 31 May Stage 2: 15 Sep	Stage 1: 31 May Stage 2: 15 Sep	Stage 1: 20 May Stage 2: 15 Sep	
Total number of proposals:	191	230	131	124	103	Stage 1: 114 Stage 2: 35	Stage 1: 120 Stage 2: 38	Stage 1: 107 Stage 2: 38	1,120³⁴
Total selected for funding	18	24	27	18	20	16	20	17	160
Total funding requested:	€1,835,820	€ 2,237,844	€ 1,124,052	€ 1,188,490	€ 1,074,638	S1: €1,099,925 S2: €326,240	S1: €1,326,145 ³⁵ S2: € 325,172	S1: €1,473,146 S2: € 403,928	€8,516,184³⁶
Total amount allocated by IAU	€90,000	€100,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€ 850,000
Total amount awarded	€ 87,703	€ 95,483	€ 114,267	€ 111,704	€ 106,207	€112,661	€113,100	€110,834	€ 851,959
Total grants paid ³⁷	€ 86,708	€ 94,483	€ 106,767	€ 108,993	€ 106,207	€ 112,661	€ 113,100	€ 110,834	€ 839,753
Grants still to be paid ³⁸	€ 0	€ 0	€ 4,000	€ 2,711	€ 0	€ 0	€ 0	€ 0	€ 6,711
Grants cancelled ³⁹	€ 995	€ 1,000	€ 3,500	€ 0	€ 0	€ 0	€ 0	€ 0	€ 5,495
Difference (allocated-awarded)	€ 2,297	€ 4,517	(€ 4,267)	(€ 1,704)	€ 3,793	(€ 2,661)	(€ 3,100)	(€ 834)	(€ 1,959)

³⁴ This total only takes into account Stage 1 proposals for 2017-2019 since Stage 2 proposals are essentially enhanced versions of selected Stage 1 proposals.

³⁵ This excludes one project which submitted an outlier proposal for €10M since that would skew the number considerably.

³⁶ This total only takes into account Stage 2 totals for 2017-2019. If we counted only Stage 1 requests for 2017-2019 the total would be €11,360,060.

³⁷ For the first three years (2013 to 2015) funds were disbursed from the OAD (IAU would transfer the full amount to South Africa from Paris). From 2016 funds are disbursed directly from the IAU in Paris, saving on exchange rate losses and additional bank fees.

³⁸ Grants still to be paid include **€4,000** for a project in 2015 which was indefinitely delayed due to family circumstances of the project leader; €1,650 for a project in 2016 that needed government approval before the transfer can be made; €1,061 remaining with the IAU for a project in 2016 which simply claimed expenses directly from Paris rather than receive the full amount (total of **€2,711** in 2016). Due to the IAU's intention to reduce project funding from 2020 these would then be cancelled.

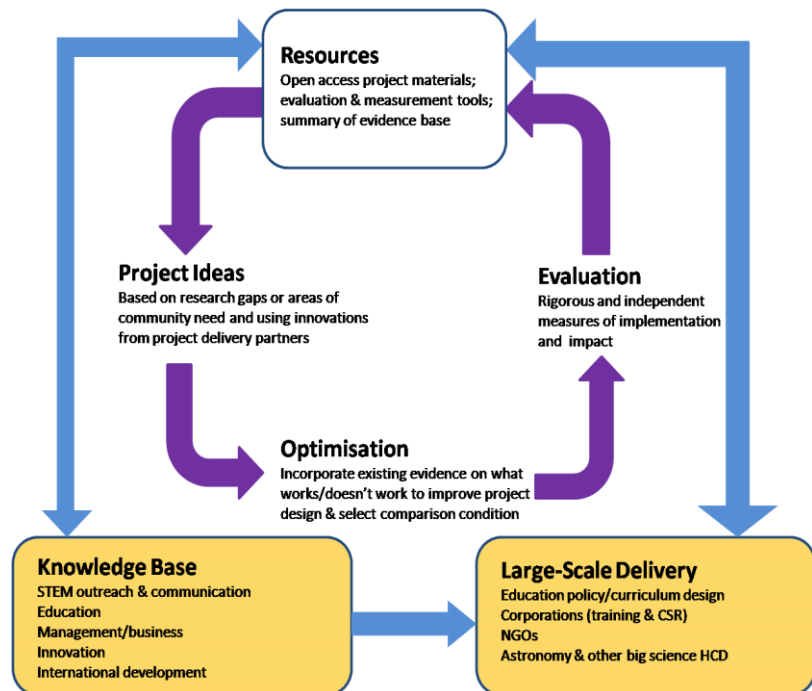
³⁹ Cancelled grants include **€995** in 2013 which was actually a surplus from a project which overestimated its budget; **€1,000** in 2014 for a project cancelled due to copyright issues; and **€3,500** in 2015 for a project cancelled due to staff movements at the host organisation.

A4. Impact of OAD Projects

Soon after the first call for proposals the OAD began reflecting on project impact. By the second call for proposals in 2013 the OAD developed a Monitoring and Evaluation (M&E) framework that would allow us to test the effectiveness of projects. However, soon after the third call for proposals in 2014, after we brought onto staff an evaluation specialist (Dr. Elizabeth Grant), we realized that the M&E framework was too general and could not be readily applied to the diversity of projects that the OAD funded. Under the leadership of Dr. Grant the OAD then began to establish a more appropriate concept referred to as the Impact Cycle⁴⁰ (Figure 3).

Figure 3: OAD Impact Cycle

This Impact Cycle aims to enhance project design, selection and delivery systems to support continual improvement and potential expansion. By determining what works and, importantly, what doesn't work, the OAD can develop a library of evidence on best practice and ensure a *positive feedback loop* for projects. The principles of the Impact Cycle have been incorporated into the call process by (i) the restructuring of the call into a two-stage process, (ii) establishment of a publicly accessible database of resources from past projects, (iii) a significant amount of information to support project proposers, including an online course, and (iv) an overhaul of the reporting system to collect more data more easily. These principles will inform all activities around projects in the next decade.



An initial overall **qualitative assessment of the impact** of OAD projects was conducted in 2019 by OAD Operations Manager, Venugopal. Apart from a more detailed analysis of the numbers, the assessment looked at two aspects: (i) impact on development, taking into account factors such as positive outcomes from the project, sustainability of activities, project reporting and resources developed, influence on SDGs, etc and (ii) success of implementation, i.e. how well they executed their plan and delivered on outputs. Some findings from this initial assessment: (i) On impact: 13% of the projects were ranked as “excellent”; 36% “very good”; 40% “average”; and 1% “low impact”; (ii) On implementation: 32% were ranked “excellent”; 48% “very good”; 9% “average”; and 1% “low”. Of the 110 projects assessed, 9 had incomplete data and 2 were cancelled. The average grant was around €5000, with only 7 projects ever granted more than €10,000. Sub-Saharan Africa accounts for the highest (31%) of the funding granted (similar to the proportion of submitted proposals), with Latin America+Caribbean the second highest (26%). OAD projects have influenced 11 out of the 17 SDG, with the majority of projects linked to SDG 4: Quality Education. The full assessment, along with interactive infographics, is available at <http://www.astro4dev.org/projects-impact/>. Note that this was largely a qualitative exercise and a more detailed scoring framework will be used for future assessments.

⁴⁰ More detail at <http://www.astro4dev.org/funded-projects/impact-cycle/>

A5. Summary of Regions

Regions are a key part of the IAU’s decadal strategies and form the global core structure that allows for both the localization and dissemination of activities where relevant. Over the past decade, eleven regional offices have been established and all remain active. Self-assessments and independent reviews have been conducted with most offices where applicable, and renewed agreements have been negotiated. The Table below provides a summary of the current status of all the regional offices and language centres, with more details in the combined business plan for regions.

Table 5: Summary and status of OAD Regional Offices and Language Centres

Region	Host country	Host institutions	Established	Due for Review	Self-assessment	Independent Review	Renewed agreement
South West and Central Asia	Armenia	Byurakan Astrophysical Observatory	2015	2019	Completed	Completed	Completed
East Asia and Chinese Language	China	Beijing Planetarium and Yunnan Observatory	2012	2016	Completed	Completed	Drafting underway
Andean Region of South America	Colombia and Chile	Universidad de Los Andes, Parque Explora-Planetario de Medellín and Sociedad Chilena de Astronomía	2015	2019	Completed	Process underway	Awaiting review
East Africa	Ethiopia	Ethiopian Space Science and Technology Institute	2014	2018	Completed	Completed	Completed
Arab World and Arabic Language	Jordan	Arab Union for Astronomy and Space Sciences at UN Regional Centre for Space Science and Technology Education	2015	2019	Completed	Completed	Completed
Europe	Netherlands	European Astronomical Society and Leiden University	2018	2022	n/a	n/a	n/a
West Africa	Nigeria	Centre for Basic Space Science, National Space Research and Development Agency	2015	2019	Completed	Completed	Completed
Portuguese Speaking Countries	Portugal	Núcleo Interativo de Astronomia (NUCLIO) and Institute of Astrophysics and Space Sciences	2015	2019	Completed	Process underway	Awaiting review
South East Asia	Thailand	National Astronomy Research Institute of Thailand	2012	2016	Completed	Completed	Completed
North America	USA	Adler Planetarium, Associated Universities Inc., Association of Universities for Research in Astronomy, and Geneva Lake Astrophysics and STEAM Education	2020	2024	n/a	n/a	n/a
Southern Africa	Zambia	Copperbelt University and University of Zambia	2014	2018	Completed	Completed	Completed

A6. Summary of Partners

The OAD has established several partnerships over the years. Some entail formal MoUs or Agreements, while others are collaborations on a specific project or topic. The table below contains a summary of key partnerships that were active during the review period.

Table 6: Summary of OAD Partners over the Review Period (alphabetical order)

Organisation	Country	Duration	Nature of partnership
African Astronomical Society (AfAS)	Pan-African	Since 2011, ongoing	Facilitation of the establishment of AfAS in 2011; facilitation of the revival and re-establishment of AfAS in 2018-2019; OAD director serves as advisor on AfAS Executive Committee
Associated Universities Inc (AUI) and Leiden University (LU)	USA and Netherlands	2014-2019	Collaborations on resource development and dissemination as well as international exchanges
Development in Africa with Radio Astronomy (DARA)	United Kingdom	Since 2018, ongoing	Annual grants (around GBP5,000 each) for astronomy-for-development projects in SKA-Africa partner countries, run by cohort of trainees from DARA workshops.
DARA Big Data	United Kingdom	Since 2019, ongoing	Appointment of a DARA Big Data Fellow at the OAD who would develop and coordinate hackathons in SKA-Africa partner countries.
DSI/NRF SARChI Research Chair in the Sociology of Land, Environment and Sustainable Development at University of Stellenbosch	South Africa	Since 2016, ongoing	This social science group studies the impact of astronomy on society and development. The partnership culminated in a jointly hosted symposium in 2019 entitled “Karoo Futures: Astronomy & its impacts”
Global Himalayan Expedition (GHE)	India	Since 2019, ongoing	This partnership revolves around the implementation of the flagship on astronomy for socio-economic development. GHE was funded by the OAD in 2018 to implement a project called “Astronomy for Himalayan Livelihood Creation” revolving around astro-tourism. The idea is to expand the principles of this project globally.
Human Sciences Research Council (HSRC)	South Africa	2018-2023	Design and implementation of science education initiatives among learners with disabilities; exploring ways in which natural and social science researchers can work in closer collaboration towards SDGs; leveraging resources to implement joint programmes and activities

Institute for Data Intensive Astrophysics (IDIA)	South Africa	2020-2021	Training of DARA Big Data fellow on IDIA research cloud and make infrastructure available in preparation for and for the duration of the schools/hackathons
Inter University Centre for Astronomy and Astrophysics (IUCAA)	India	2012-2015; 2018-2021	Education, Outreach and Research Level Exchanges (visiting fellowships at IUCAA); testing of resources and projects support in India; grassroots collaboration on science for development in India; content management platform for project resources.
International Centre for Theoretical Physics (ICTP)	Italy	2012-2015	Suite of grants related to astronomy for development including associate scientists, twinning programmes, travel grants, workshops and schools.
International Science Council Regional Office for Africa (ISC ROA)	South Africa	2019-2020	Joint implementation of the international OAD-ISC ROA Science for Development Workshop which took place in January 2020. <i>This event had 17 other partner organisations (see www.science4dev.org).</i>
Netherlands Organisation for Scientific Research (NWO)	Netherlands	2012-2015	Visiting “experts” (scientists, engineers, educators) based in the Netherlands are granted funds to travel to developing countries
South African IAU National Committee and GA2024 National Organising Committee	South Africa	Since 2015, ongoing	Support for the preparation of the 2015 and 2018 bids to host the IAU GA in South Africa; preparation for IAU General Assembly 2024
Space Generation Advisory Council (SGAC)	Vienna	Since 2018, ongoing	Sharing of information and opportunities within each other’s networks, engaging with each other’s communities and collaborating on specific global and local campaigns
Research in Socio-Economic Policy (RESEP) at University of Stellenbosch	South Africa	May to Dec 2019	Hosting of OAD-RESEP Development Economics Fellow (PhD student); co-supervision of students; new projects/funding sources
Royal Astronomical Society (RAS)	United Kingdom	Since 2012, ongoing	Annual mobility grants (GBP10,000 in total) to establish or nurture research, educational and/or development related collaborations between the UK and countries where astronomy is not well established.
University of Zululand (Unizul)	South Africa	Since 2017, ongoing	Introduction of astronomy to enhance skills and training within the university’s Physics department, and the establishment of an optical observatory with an associated community development component.