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ASTRONOMY DEVELOPMENT AND FILMMAKING IN THE KAROO

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ABSTRACT

The Square Kilometre Array when completed will be the largest radio telescope in the world. The core of the African part of the array will be located in South Africa in the Karoo Desert. The town closest to the core is Carnarvon, the capitol of the Kareeberg Municipality. *SKA ≥ Karoo Radio Telescope* is a documentary film that captures the hopes and dreams of the people living near the SKA core and a variety of SKA stakeholders. The film is an experimental form of research ethnography centered around a set of hypotheses that were tested through the interviews conducted for the documentary. For example, one of the hypotheses was that the long term beneficiaries of the SKA will be the astronomers regardless of their proximity to Carnarvon, and that those beneficiaries would have very weak to non–existent ties to Carnarvon or that region of the Karoo Desert. Another hypothesis was that the people of Carnarvon would not have a clear understanding of the nature of astronomy development projects in contrast to traditional development projects. Transcripts from film clips are used to illustrate the 'answers' to these hypotheses and other tensions surrounding the SKA. Finally, the title tries to capture the pride and sense of ownership that people in the region and South Africa have towards the SKA, but it is much more than a regional or national telescope.

KEYWORDS: Square Kilometre Array, Astronomy & Society, Science Studies, Astrophysics, Carnarvon (SA), South Africa, Karoo Desert, Science & Development

1. ASTRONOMY IN SOUTH AFRICA

The first astronomical observatory in South Africa was established in 1820 as the Royal Observatory of the Cape of Good Hope. As Cape Town grew, so did light pollution. The location of the observatory so close to Cape Town, and now within Cape Town, has made it difficult to make astronomical observations of deep sky objects. The South African Astronomical Observatory (SAAO) was established in 1972 and a new optical astronomy site in Sutherland was created. Sutherland is nearly 400 kilometres away from SAAO headquarters in Cape Town. Sutherland is a high, 1800 meters above sea level (*SALT*, 2016), and dry site in the Karoo desert region of South Africa. Since 1972, the Sutherland site has expanded housing several telescopes including the largest optical telescope in South Africa – SALT (the Southern Africa Large Telescope). SALT is a 10–metre class telescope with a sectional mirror; it was dedicated in 2005. In 2012, South Africa was chosen to host the next generation radio observatory – the Square Kilometre Array (SKA). The optimal location for the core of the radio telescope was situated in the Karoo Desert near the town of Carnarvon (Dewdney et al., 2009). To ensure that the pristine conditions of radio dark skies were preserved for all time, legislation was passed creating an astronomy geographical advantage zone centred on the SKA site (Creamer Media Reporter, 2008). The SKA site is about three hundred kilometres away from Sutherland, and over six hundred kilometres away from SAAO headquarters in Cape Town. As with SAAO, the SKA headquarters are in Cape Town.

2. THE SQUARE KILOMETRE ARRAY: LIVELIHOODS AND EXPECTATIONS

South Africa achieved a victory when they won the bid to host the Square Kilometre Array (Amos and News, 2012). They are the hosts of one of the two cores of the telescope: the core that covers mid radio frequencies from 350 MHz – 14 GHz (Isidro, 2015; SKA South Africa, 2012). The second core will be located in Australia and will cover a different radio frequency range. The South African government, as part of the developing world, made the choice to promote astronomy and astrophysics as part of their development agenda. Through the development of world–class astronomy facilities, they include the goals of workforce development and future techno logical advancements, thus justifying the large financial expenditure (Pandor, 2011).

> For the Carnarvon community, when it was introduced, I think it was misunderstood. In the sense, that there were a lot of expectations from the Square Kilometre Array. Maybe I could say that it was perceived as the savior of the Carnarvon community. That it would bring about a drastic change in our community. There were rumors that they will have shopping malls. Carnarvon would change and be something else. It would beautify Carnarvon, than it is now. So that is how the community perceived it, the Square Kilometre Array. I think the perception is still there that it should bring upon change, develop change in Carnarvon. It is seen as a tool to change or take over for the one that is responsible for the development of the town. It is seen as, it should do all that, all those functions that are supposed to be done by the municipality or maybe business owners in Carnarvon.
>
> Sisanda Manda, Carnarvon Social Worker

Astronomy development projects, i.e. the creation of observatories, are different from other types of development projects. As the South African Astronomy Geographical Advantage Act indicates, observatories and the regions near the observatory are zoned against most projects and activities that are associated with development. The Astronomy Geographical Advantage Act places limitation on radio waves and other types of electromagnetic pollution. In particular, radio stations had to switch to digital systems and can only broadcast at approved frequencies; no short wave radios are allowed, and cell phones must be turned off on the SKA grounds. There are regulations against mining, construction, light pollution, and air pollution (Creamer Media Reporter, 2008; Ngcobo, 2011).

Given previous tensions between observatories and nearby local communities (Hall, 2015), I expected that various SKA stakeholders would have different expectations about what the SKA would do to and for their communities in South Africa (read more about protests around Mt Graham in Arizona (Ferman, 2013; Ojibwa, 2010), Mauna Kea in Hawaii (Fox, 2015; Lillie and Prescod–Weinstein, 2015; McFarling, 2001), Haleakala in Hawaii (Gutierrez, 2015; Monson, 2006; Nabarro, 2017). In 2014, I wrote a grant proposal to the South African National Research Foundation to explore four hypotheses connected to the Square Kilometre Array.

1. There will be a diversity of views as to what the SKA project means in terms of local and regional development.
2. Few stakeholders will be aware of the limited access 'natural park' and 'under–development' nature of the SKA project.

3. The scientists involved with SKA will have weak or non–existent links to the Karoo community surrounding SKA.
4. If traditional healers make use of the SKA site, their perceptions of the SKA site will differ greatly from all other stakeholders.

The four hypotheses attempt to capture the disconnect between the scientific, engineering, and political SKA stakeholders and the stakeholders living near the SKA site in the Karoo. The long–term beneficiaries of the SKA will be the scientific stakeholders, and hypothesis 3 predicts that those scientists will not be from the Karoo. Hypothesis 2 points to the unique nature of astronomy development projects, that they are more like under–development projects in that in order to keep the observing site optimal, it must remain the same. Thus, nothing can be built around the observatory that would destroy the naturally dark skies. Additionally, the population near the observatory is discouraged from growing, because increasing the population adds to various forms of pollution that will impact the quality of the skies at the SKA site. The SKA site, like most observatories, can be equated to a national park rather than a development project, except public access is restricted; thus, it may be described better as a military base. Experimentally, I proposed to make a documentary film exploring these hypotheses and the SKA stakeholder communities rather than writing a manuscript (Holbrook, 2016).

Figure 1. Still from the film SKA ≥ Karoo Radio Telescope (Holbrook, 2016).

3. INTERVIEWING FOR THE FILM

After purchasing equipment and assembling two film crews made up of colleagues and students; filming took place in 2014 and 2015. Locations included the town of Carnarvon in the Karoo, SKA science meetings in Stellenbosch and Cape Town, and at the University of the Western Cape. I was able to interview scientists, politicians, construction workers, engineers, and people living in the Karoo. Communities that I attempted to connect to, but failed, were the conservationists and traditional healers; therefore, I was unable to explore hypothesis 4.

Interviewing for the film always began with the signing of consent forms, or with recording a verbal consent. Only three questions were asked. These were in order:

1. What does the Square Kilometre Array mean to your community? First define your community.
2. What does the Square Kilometre Array mean to you personally?
3. What do you see as the future of the Square Kilometre Array for your community?

People interviewed either spoke in English or in Afrikaans. Postgraduate student Dawn Bosman, Postdoc Barbara Mashope, and local businesswoman Lillian Andreas aided with the Afrikaans interviews. The English interviews were conducted by me and postgraduate student Rodwell Ndlovu. Bosman and Ndlovu are shown in a behind the scenes short that can be found on YouTube (AICT: Carnarvon 2015, 2015).

4. TESTING THE HYPOTHESES

The four hypotheses were tested through interviewing people for the film. Though the three questions asked were not directly addressing the hypotheses, they were open ended such that their statements could be used for testing the hypotheses. Quotes are used to illustrate points used to test the hypotheses in the sub–sections below. Since no traditional healers were interviewed, hypotheses four was not addressed and therefore was not tested.

4.1. There will be a diversity of views as to what the SKA project means in terms of local and regional development

The film opens with clips from an interview with Sarah Wild, who wrote a book on the Square Kilometre Array (Wild, 2012).

> For the most part science was something that happened somewhere else. Especially good useful science. A lot of the science that was done in South Africa, that South Africa was famous for, was nuclear weapons, was nuclear technology: It was different ways to kill people. And here was Radio Astronomy which was this benign way to develop capital. And to get involved in science or to highlight the science done in South Africa.
>
> Sarah Wild, Author

The quote by Sarah Wild is in contrast to that of Sisanda Manda in Section 2. Wild's view is that the SKA will benefit the country; whereas, Manda's describes how the people of Carnarvon were expecting the SKA to develop Carnarvon in terms of bringing in businesses and giving the town a facelift.

4.2. Few stakeholders will be aware of the limited access "natural park" and "under–development" nature of the SKA project

> I was very proud. I was on cloud nine, because I don't know much about these things. I did some general science in school and I was very interested. I could follow the conversations. And then there was that period where we didn't know who, what country would receive this thing. And when it happened that Carnarvon got it, we were over the moon. Our expectations were too high, but we expected something. So far we see nothing. We were in cloud nine. But we are slowly falling out. Because when you really feel bad about all this, is when you go to a city outside of Carnarvon. People hear that you are from Carnarvon. "Oh, so you from that place where the SKA is!" Yes, now they are interested. Now they want to know. Now we know nothing! We don't even know where it is. People come from all over. They have meetings here. We go to the meetings. They tell us how much we are a part of it. We have asked that trips be arranged for us to go and see.
>
> Louisa Hendricks, Health Worker (retired), Skeitfontein

Louisa Hendricks' quote points to the lack of access to the SKA site, as if a military base. Her quote also addresses hypothesis 2, in that she expected something would be done to make Carnarvon better but that nothing had happened.

Figure 2. To enter the Square Kilometre Array facility, you must be signed in, have an established appointment, and show identification much like a military base (Holbrook, 2016).

4.3. The scientists involved with SKA will have weak or non–existent links to the Karoo community surrounding SKA.

> I am actually from Carnarvon. I have been involved in doing SKA related work since my Honours year. It has been fun! I have been doing high speed compression in my Honours year.
>
> Ben Hugo, Master's Student

Among the scientists, I met only one person from Carnarvon, a Master's student in computer science at the University of Cape Town: Ben Hugo. His project was to study ways of compressing the data that will come from the radio telescope (Hugo, 2013). No other scientists were identified as coming from near the SKA site in the Karoo.

5. CONCLUSIONS

The quotes and photographs included provide a sampling of the film and the research. The film format was ideal for presenting the myriad of responses and opinions about the Square Kilometre Array. Summarizing the responses, the politicians in Carnarvon, the scientists, and those funded by the SKA had wonderful things to say about the SKA. Carnarvon business people that had taken advantage of the emerging market associated with the SKA construction also had good things to say about the SKA. Contractors from Carnarvon that had worked during the construction phase were positive, but had hoped that they would get further contracts, which had not happened. A similar sentiment was held by those teaching in Carnarvon: the SKA had helped improve the teaching of science and had donated equipment, but they wanted more SKA involvement in order to increase the success of their science learners. The remaining Carnarvon people were disappointed that very little had changed for their town. They expected the SKA to do things that normally the local and regional government does. They did have expectations of development rather than the reality of under–development.

Testing the hypotheses, there was a diversity of views about what the SKA meant as a development project (hypothesis 1): The people of Carnarvon who were not connected to the regional government or the SKA project, had expectations that the SKA and their money would step in to do the work of regional and local government. Most people that were interviewed in Carnarvon did understand that new shopping malls, etc., were not going to come but still wanted the SKA to spend money to improve the local infrastructure to make the town more attractive – again the work of local and regional government. The scientists, especially the astrophysicists, knew from experiences with other observatories that the surrounding towns and communities are required to remain small (underdeveloped) to prevent electromagnetic pollution that would ruin the site (hypotheses 1 and 2). The astronomers, engineers, and government officials from the National Research Foundation (NRF) and the Department of Science and Technology (DST) that were interviewed, did have an understanding that the SKA would be a limited–access facility with heavy restrictions for entry, like a military base (hypothesis 2). The Carnarvon interviewees had expectations that they would be allowed to go there at some point since most had never been to the site. The scientists, engineers, and NRF/DST officials were all not from Carnarvon or even from the Karoo region of South Africa, but for Ben Hugo (hypothesis 3). Most had never been to Carnarvon before the SKA project was proposed. Thus, the hypotheses held except for the third; however, a modification would be to state that *most* scientists would have weak or non–existent ties to the Karoo region surrounding the SKA site.

Constructing the film *SKA ≥ Karoo Radio Telescope* involved showing the mix of responses. However, only the most engaging interviews could be used in the final version of the film. This was further confounded by bad lighting, bad sound, or both. *SKA ≥ Karoo Radio Telescope* is a combination film: both a presentation of research results and a documentary film. The film is subtitled throughout and runs for 49.24 minutes. Audience response has been mixed in that South African audiences enjoy the film, but American audiences find it long and boring. In order to appeal to an international audience, the film needs to be reedited and shortened to about 20 minutes, which is not enough time to show the range of opinions about the Square Kilometre Array.

Finally, the research and the film were opportunities to train postgraduate students at the University of the Western Cape. Rodwell Ndlovu and Dawn Bosman learned about astronomy, radio telescopes, the Karoo Desert and its small towns, and how to conduct research with people as the subject. In terms of filmmaking, they learned how to get people to relax on camera, how to set a frame, and how to edit film.

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