Environmental challenges to operationalisation of South African rainfall enhancement

Karen Shippey[1]*, André Görgens[1], Deon Terblanche[2] and Mike Luger[1]
[1]Ninham Shand, PO Box 1347, Cape Town 8000, South Africa
[2]South African Weather Service, Private Bag X15, Bethlehem 9700, South Africa

Abstract

Most of the atmospheric moisture in systems moving across South Africa leaves the sub-continent as the weather systems move out over the ocean, only a tenth of it falls on the landmass as rain. An increase in the efficiency of the atmospheric moisture delivery system by means of rainfall enhancement is therefore an attractive concept. Rainfall enhancement functions by either providing additional Cloud Condensation Nuclei or Ice forming Nuclei that will beneficially influence the precipitation formation process, improving the efficiency of moisture to rainfall conversion.

Systematic South African research into rainfall enhancement started in the 1970s. The South African Rainfall Enhancement Programme (SAREP), initiated in the late 1990's, is the most recent in a series of studies and was the first semi-operational rainfall enhancement project to occur in South Africa as a response to drought conditions. In a recent study (DWAF, 2004 in prep) to finalise SAREP and provide guidance on operationalising rainfall enhancement, it was recommended that environmental impact assessment must be undertaken before this technology is implemented further.

Rainfall enhancement falls specifically within the jurisdiction of the National Water Act (NWA) and the National Environmental Management Act (NEMA). A licence to undertake rainfall enhancement activities is required from the Minister of Water Affairs and Forestry after an appropriate environmental impact assessment has been undertaken to inform his decision. This paper proposes an approach to fulfil the legal requirements for operationalising future rainfall enhancement.

The interaction between the science of rainfall enhancement and the ability of scientific disciplines to determine relevant environmental impacts, to appropriately inform the decision-making process, is specifically highlighted. The data requirements identified by scientists during the study varies in duration and resource needs and does not differentiate between ongoing scientific research and the requisite information required for informed decision making. This paper contemplates an approach which provides for holistic and co-ordinated investigation of South African rainfall enhancement into the future.

Background

South Africa is an arid country, with an average annual rainfall of about 480 mm. The low rainfall exacerbated by climatic variation (both natural and human induced) make the country vulnerable to water shortages and threaten food production. These concerns inspired South African scientists to look to the clouds for additional water supply. Research has shown that an average of 10% of the moisture in atmospheric systems moving across South Africa falls as rain. Most of the atmospheric moisture leaves the sub-continent as the weather systems move out over the ocean.

The terms rainfall enhancement, weather modification and cloud seeding all refer to the artificial introduction of additional particles into clouds around which raindrops can form. In nature, the concentration, size distribution and type of cloud condensation nuclei or ice nuclei are not always suitable for optimum rainfall efficiency. The principle of rainfall enhancement is to release artificial nuclei into the cloud at the right time and location, such that the formation of cloud droplets and ice particles is triggered in a more optimal manner. In so doing, the clouds ability to produce rainfall is enhanced. This technology allows for rainstorms to increase in duration and area rather than intensity. Rainfall enhancement can only stimulate raindrop formation where clouds already exist and meet particular physical criteria; it cannot "create" rain.

Systematic international research of rainfall enhancement dates back to the 1940s and South African research started in the 1970s. The South African Rainfall Enhancement Programme (SAREP), initiated in 1997, was the most recent in a series of studies in rainfall enhancement to occur in South Africa as a response to drought conditions. The "target area" for the SAREP operations was a 100 km x 100 km block between Polokwane and Tzaneen in the Limpopo Province. Cloud climatology studies for the SAREP project show that a 7-10% increase in rainfall can be achieved in the target area. The results of much of this work provide sound evidence that the application of rainfall enhancement techniques can result in statistically significant increases in rainfall. The diagram below (Fig. 1) presents a comparison of the average rain mass of seeded and unseeded clouds as measured by radar during SAREP. The average seeded storm produced about 8 000 kton more rain than the average un-seeded storm.

Legislation

Rainfall enhancement is listed in Section 37(1) of the National Water Act (NWA) as a controlled activity requiring authorisation. In the explanatory note to Section 37, the NWA describes controlled activities as requiring specific permission as they may have "a detrimental effect on water resources". In this case, it is likely to increase water resources but the uncertainties center on the potential impact the activity may have on the receiving environment. The NWA says that the Minister of Water Affairs and Forestry must

This paper was originally presented at the 2004 Water Institute of South Africa (WISA) Biennial Conference, Cape Town, South Africa, 2-6 May 2004.
* To whom all correspondence should be addressed.
☎+2721 481-2400; fax: +2721 424-5588;
e-mail: karen.shippey@shands.co.za