The Kaukausib catchment in southwestern Namibia: Drainage network, surface runoff and vegetation feedback after extreme rainfalls

50° 55′ 39″ N
6° 56′ 10″ E
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Introduction

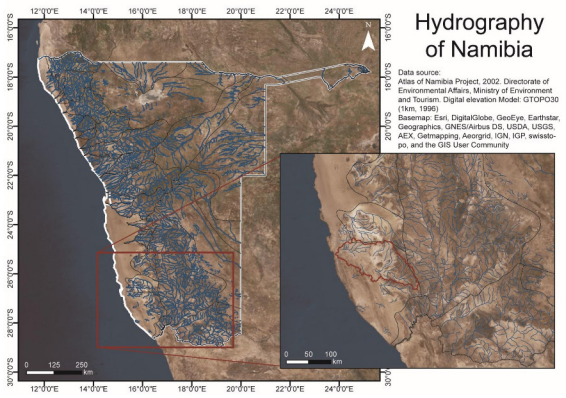
Our study focusses on the Kaukausib catchment in SW-Namibia using freely available remote sensing and geographical information systems. Firstly, we identifed the drainage network derived from free available digital elevation models (SRTM-1 and ASTER GDEM V2). Secondly, based on the example of 2006, we present a time series of vegetation indices (NDVI from LANDSAT 5) after extreme rainfall events in this arid environment, showing the strong feedback of surface runoff and vegetation change.

1. What are the landscape characteristics of the Kaukasib catchment?

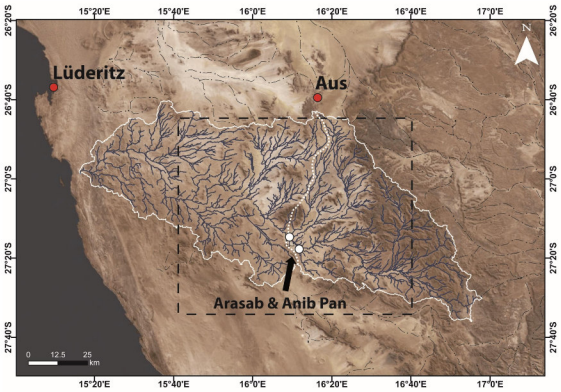
2. What causes the genesis of the extreme rainfalls in the southern Namib in 2006?

3. What is the temporal and spatial effect for vegetation growth after these rainfalls?

1 Drainage System Analysis

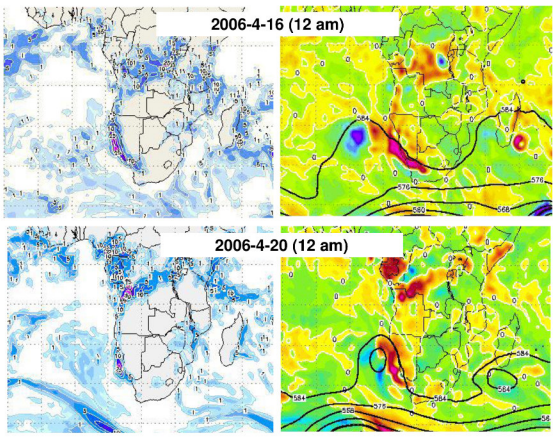


The drainage network systems of Namibia, derived from relatively coarse resolution (1km) of the GTOPO30-DEM (1996). Here, the south-western part of Namibia shows a less established drainage network.

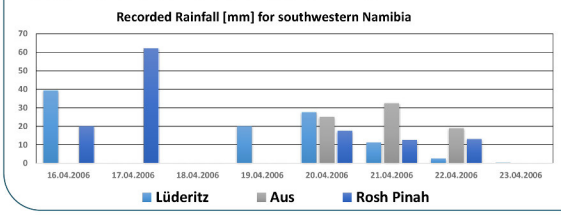


In contrast, the drainage network calculated from the more recent free available DEM´s with 30m resolution (e.g. ASTER GDEM V2 from 2011 or SRTM from 2014) shows a well established fluvial system, which allows further investigation.

2 Extreme rainfalls in April 2006



6 h cumulated precipitation (mm, left), 500 hPa geopotential and vertical movement (hPa/h) over southern Africa.



Some of the heaviest rainfall in the southern Namib desert occured in 2006.

Lüderitz received the highest rainfall recorded ever between the 16.4. and 23.04.2006.

Most likely, the appearance of La Nina Conditions, a Benguela-Nino and a positive phase of the Southwest Indian Ocean dipole at the same time, were favourable for the development of two linked rain-bearing systems over coastal Namibia:

(1) a so called Tropical Temperate Through (TTT) placed unusually far west, forcing tropical convection southwards and

(2) a Cut-Off-Low (COL) approaching the coast unusually far north.

The TTT might have caused rainfall on 16.April while the COL seems to be responsible for precipitation further inland by the end of the week.

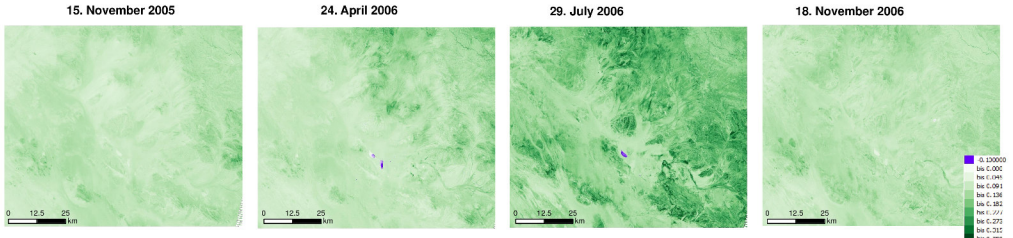
3 NDVI: LANDSAT 5

A spatial distribution of a Normalized Difference Vegetation Index (NDVI) was applied to the study area over a time series from November 2005 to November 2006. It was derived from multispectral Landsat 5 CDR data using Band 4 (Near Infrared) and Band 3 (Visible Red).

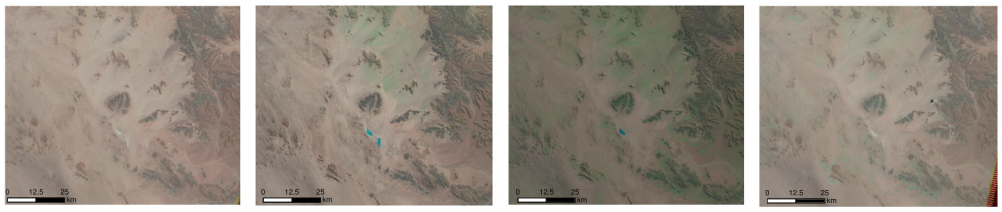
The results indicate that plant cover distribution over time and space is related to both the speed of the overland flow and soil water storage. Thus vegetation distribution is influenced by both topographical features, drainage channels and the distribution of dominant soils over the study area.

Very little vegetation feedback was observed immediately after the rainfall events, while the greatest, most dense and most vital vegetation cover was present in July.

Namib plains before and after a rainfall event



NDVI values in 2006 showing the strongest vegetation feedback in late July, three months after the event.



Landsat 5 pictures of the study area. The water is stored in the temporary lakes of Arasab and Anib Pan (see also drainage system analysis) and did not reached the atlantic.

Conclusions

1. **In total, the Kaukausib catchment is draining from the Great Escarpment towards the Atlantic. However, nowadays surface runoff is not reaching the Atlantic and is limited to the Arasab and Anib pan.**

2. **Rainfalls in 2006 were caused by two different, yet interlinked rain-bearing systems: a) a tropical-extratropical link of enhanced convection and b) an midlatitude cyclone, which reached unusually far north.**

3. **NDVI values show a strong feedback up to three months after the rainfall event over almost the whole study area. The spatial distribution is dependent on hydrology, pedoloy and topographical features.**