

Phenological advance of Jacaranda Bloom in Gauteng Province, South Africa

Jennifer Fitchett and Kestrel Raik

School of Geography, Archaeology and Environmental
Studies, University of the Witwatersrand, South Africa

PHENO
2022

Jennifer.Fitchett@wits.ac.za



Phenological advance of blossoming over the past century in one of the world's largest urban forests, Gauteng City-Region, South Africa

Jennifer M. Fitchett*, Kestrel Raik

School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa

ARTICLE INFO

Handling Editor: A. Alessio Pini

Keywords:
Jacaranda
Flowering
Phenology
Climate
Gauteng
South Africa

ABSTRACT

The Gauteng City-Region in the northern interior of South Africa hosts one of the world's largest and most densely vegetated urban forests. The tree species, distributed across pavements, parks and suburban gardens, comprise a range of indigenous and alien species. The most aesthetically distinct of these is *Jacaranda mimosifolia* (Bignoniaceae), a purple-blossoming tree introduced from Brazil in the 1800s to beautify the cities. The distinct appearance during flowering and their abundance in the Gauteng City-Region has resulted in reporting of peak flowering events in local newspapers throughout the past century. This provides a valuable phenological record, particularly in southern Africa where phenology is seldom recorded. Analysing these reports of *Jacaranda mimosifolia* flowering, an advance of 2.1 days per decade is calculated for the period 1927–2019. This occurs against a backdrop of statistically significant annual and monthly temperature increases of ~ 0.1 – 0.2 °C/decade for T_{\max} and ~ 0.2 – 0.4 °C/decade for T_{\min} , and non-uniform change in rainfall. This phenological advance is most significantly related to winter climatic conditions, including T_{\max} , rainfall and frost occurrence. The strongest phenological driver is June T_{\max} , at a rate of 4.3–5.3d/°C across the City-Region. This advance reflects the response of the tree to regional climate warming, which poses threats to the species and the urban forest in the long term when thresholds for adaptation are surpassed.

1. Introduction

The Gauteng City-Region, a metropolis which encompasses the municipalities of Tshwane (Pretoria), Johannesburg and Ekurhuleni in

Conservation of Agricultural Resources Act 1983 (CARA, 1983) due to their water consumption in the semi-arid region (Stoffberg, 2006), and deliberate replanting is thus prohibited but existing trees are not deliberately removed (Turton et al., 2006). Despite the invasive status,

Phenological research in southern Africa

- Paucity of ground-based records
- DRP – challenges with theft of cameras, and storage of data
- Remote sensing – issues of spectral mixing
- Grab and Craparo – Apple and Pear blossoms, SW Cape
- Fitchett et al. – Sardine Run KZN coast
- Snyman and Fitchett – Namaqualand Daisies
- Whitecross – Savanna tree-grass greenup



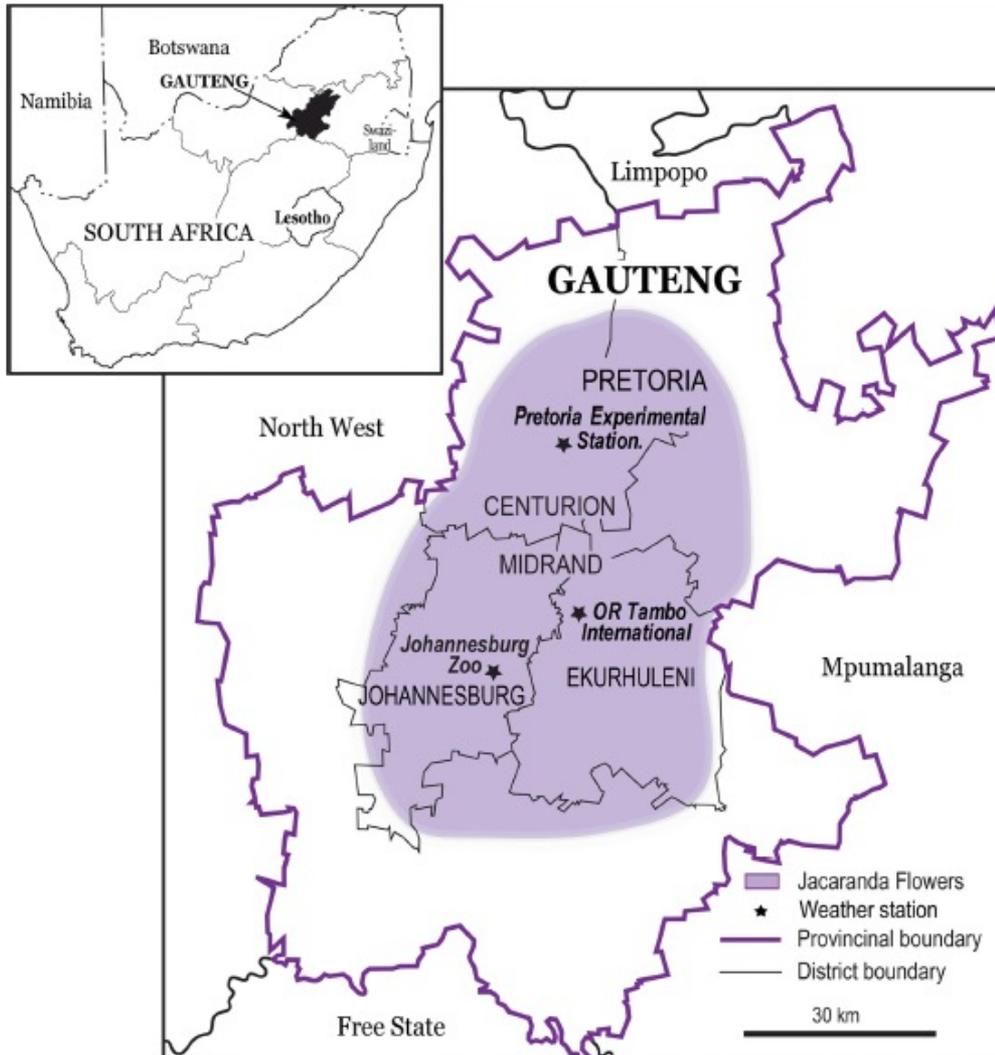
Utilizing media reporting

- Phenological events which form part of public culture are often well-documented in the print media, and more recently in social media
- Eg. Japanese Cherry Festival

To form valuable components of a phenological database, these need to be

- Easily and unambiguously identifiable
- Have a distinct phenological **event**
- Have a well-understood geographic range

Jacarandas of Gauteng City-Region



25.5-26.5°S, 27.7-28.4°E

1500 m.asl

2% of the landmass of South Africa

MAT 22°C Johannesburg

25°C Pretoria

MAP 600-700mm

Jacarandas of Gauteng City-Region

- Gauteng City-Region one of the world's largest urban, man-made forests covering 16.1% of the terrestrial area
- City of Johannesburg alone has over 10 million trees
- Among these are *Jacaranda mimosifolia*
- Introduced from Brazil in the early 1800s to Pretoria and later Johannesburg to beautify the newly developed suburbs
- Today Jacaranda are classified as a category 3 alien invasive species, replanting prohibited

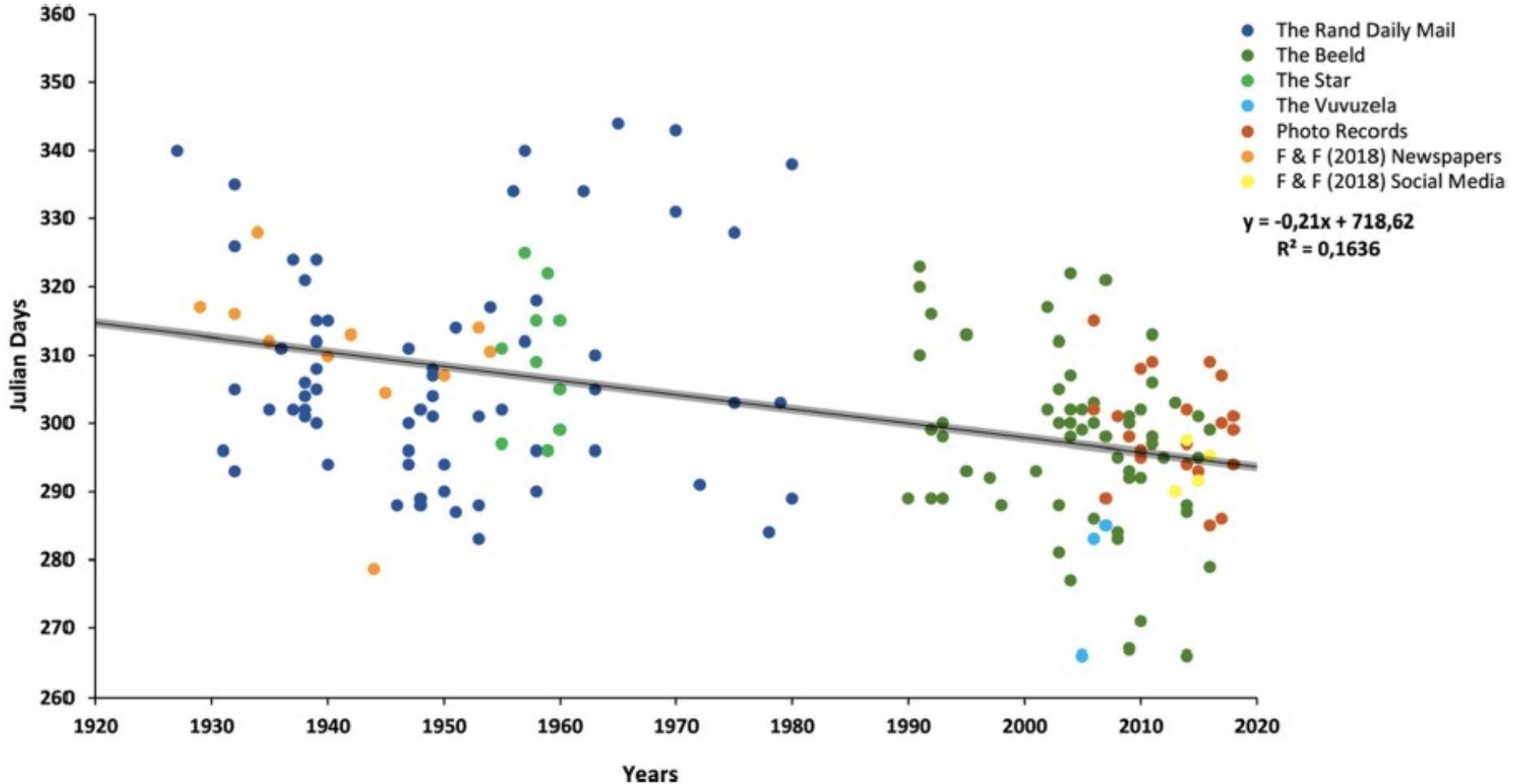
Jacarandas of Gauteng City-Region

- Jacaranda trees blossom late spring, typically during October and November
- Residents of the City-Region flock to the tree-lined suburbs each year to photograph the blossoms, and a small number of tourists travel from elsewhere in South Africa to see them
- News reports have recorded the flowering period for much of the past century
- Since the advent of social media, these blossoms have been photographed and often geotagged

Jacaranda Phenological Study

- Digitized records from the Rand Daily Mail on Readex spanning 1927-1980
 - 68 useable records
- Digitized records from Die Beeld at Media24 Head Office spanning 1980-2019
 - 66 useable records
- Hard copies of The Star and The Vuvuzela newspapers for 1919-1923, 1950-1969 and 1970-2013
 - 13 useable records
- Citizen science campaign for dated, geolocated photos
- Social media analysis

Jacaranda Phenological Study



Jacaranda Phenological Study

Month	Pretoria Experimental Station (rain 1918-2014; temp 1931-2018)			OR Tambo International Airport (1946-2019)			Johannesburg Zoo (1919-2019)
	T _{max}	T _{min}	Rainfall	T _{max}	T _{min}	Rainfall	Rainfall
January	0.02°C/yr r = 0.37 p = 0.0008	0.05°C/yr r = 0.67 p < 0.0001	0.30mm/yr r = 0.12 p = 0.2627	0.01°C/yr r = 0.14 p = 0.2510	0.02°C/yr r = 0.44 p = 0.0001	+0.39mm/yr r = 0.13 p = 0.2852	+0.35mm/yr r = 0.13 p = 0.1934
February	0.03°C/yr r = 0.35 p = 0.0014	0.04°C/yr r = 0.52 p < 0.0001	-0.01mm/yr r = 0.01 p = 0.9627	0.01°C/yr r = 0.21 p = 0.0798	0.02°C/yr r = 0.47 p < 0.0001	+0.29mm/yr r = 0.11 p = 0.3592	+0.30mm/yr r = 0.12 p = 0.2215
March	0.02°C/yr r = 0.31 p = 0.0057	0.05°C/yr r = 0.8 p < 0.0001	0.17mm/yr r = 0.07 p = 0.4789	0.01°C/yr r = 0.18 p = 0.1382	0.02°C/yr r = 0.39 p = 0.0006	0.18mm/yr r = 0.07 p = 0.5547	0mm/yr r < 0.01 p = 0.9948
April	0.01°C/yr r = 0.18 p = 0.1137	0.05°C/yr r = 0.79 p < 0.0001	0.11mm/yr r = 0.09 p = 0.4015	0.01°C/yr r = 0.14 p = 0.2286	0.01°C/yr r = 0.27 p = 0.0194	-0.20mm/yr r = 0.13 p = 0.2939	+0.15mm/yr r = 0.12 p = 0.2550
May	0.02°C/yr r = 0.34 p = 0.0020	0.05°C/yr r = 0.80 p < 0.0001	-0.18mm/yr r = 0.20 p = 0.0511	0.02°C/yr r = 0.39 p = 0.0007	0.03°C/yr r = 0.38 p = 0.0008	-0.04mm/yr r = 0.04 p = 0.7681	-0.15mm/yr r = 0.16 p = 0.1113
June	0.02°C/yr r = 0.46 p < 0.0001	0.05°C/yr r = 0.74 p < 0.0001	0.03mm/yr r = 0.07 p = 0.5152	0.02°C/yr r = 0.40 p = 0.0005	0.02°C/yr r = 0.33 p = 0.0048	0.03mm/yr r = 0.05 p = 0.6865	-0.01mm/yr r = 0.02 p = 0.8679
July	0.02°C/yr r = 0.38 p = 0.0005	0.05°C/yr r = 0.77 p < 0.0001	0.10mm/yr r = 0.21 p = 0.0416	0.01°C/yr r = 0.28 p = 0.0175	0.01°C/yr r = 0.21 p = 0.0757	-0.01mm/yr r = 0.03 p = 0.8182	-0.12mm/yr r = 0.22 p = 0.0265
August	0.01°C/yr r = 0.19 p = 0.0844	0.04°C/yr r = 0.28 p = 0.0123	0.12mm/yr r = 0.23 p = 0.0217	0.02°C/yr r = 0.27 p = 0.0227	0.02°C/yr r = 0.28 p = 0.0182	0.02mm/yr r = 0.04 p = 0.7516	+0.02mm/yr r = 0.05 p = 0.6462
September	0.02°C/yr r = 0.26 p = 0.0184	0.06°C/yr r = 0.69 p < 0.0001	-0.06mm/yr r = 0.07 p = 0.5285	0.02°C/yr r = 0.29 p = 0.0117	0.02°C/yr r = 0.34 p = 0.0031	0.03mm/yr r = 0.02 p = 0.8524	-0.02mm/yr r = 0.02 p = 0.8829
October	0.02°C/yr r = 0.26 p = 0.0206	0.05°C/yr r = 0.54 p < 0.0001	0.09mm/yr r = 0.05 p = 0.6080	0.02°C/yr r = 0.24 p = 0.0386	0.01°C/yr r = 0.16 p = 0.1753	-0.13mm/yr r = 0.07 p = 0.5889	-0.02mm/yr r = 0.01 p = 0.9160
November	0.01°C/yr r = 0.20 p = 0.0781	0.04°C/yr r = 0.66 p < 0.0001	-0.18mm/yr r = 0.09 p = 0.4045	0.02°C/yr r = 0.35 p = 0.0024	0.01°C/yr r = 0.31 p = 0.0085	-0.45mm/yr r = 0.19 p = 0.1236	-0.13mm/yr r = 0.06 p = 0.5359
December	0.01°C/yr r = 0.18 p = 0.1050	0.05°C/yr r = 0.72 p < 0.0001	-0.11mm/yr r = 0.06 p = 0.5649	0.01°C/yr r = 0.21 p = 0.0778	0.02°C/yr r = 0.43 p = 0.0001	0.18mm/yr r = 0.08 p = 0.4960	+0.06mm/yr r = 0.03 p = 0.7968
Annual	0.02°C/yr r = 0.54 p < 0.0001	0.04°C/yr r = 0.85 p < 0.0001	0.18mm/yr r = 0.03 p = 0.7618	0.01°C/yr r = 0.39 p = 0.0006	0.02°C/yr r = 0.44 p < 0.0001	0.13mm/yr r = 0.02 p = 0.8941	-0.02mm/yr r < 0.01 p = 0.9749

Strongest phenological response is to June T_{max} 4.2-5.3d/°C

Weaker relationships with mean annual T_{min} 3.14d/°C, and mean monthly T_{min} for Jan-May

Statistically significant relationship between flowering dates and rainfall in July 0.33d/mm

In 2021 first rainfall was delayed, and first bloom followed within 3 days.

Avenues for Future Research

- Continued work using a combination of traditional and social media posts – Namaqualand Daisies and the migration dates of the Brown-Veined White Butterfly
- Continued work on Jacaranda flowering, including a large scale mobile phone-based geolocated survey Citizen Science project
- Exploring avenues for remote sensing, addressing the issues of spectral mixing and the density of the urban forest

Questions?

Jennifer.Fitchett@wits.ac.za

Twitter: @jenfitchett

Fitchett, J.M and Raik, K. 2021. Phenological advance of blossoming over the past century in one of the world's largest urban forests, Gauteng City-Region, South Africa. *Urban Forestry and Urban Greening*, 63, 127238.