

Assessing vulnerability of rural communities to climate change: A review of implications for forest-based livelihoods in South Africa

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Abstract

Purpose – The paper aims to enhance the understanding of the impacts of climate change on rural communities in Africa, including people's livelihoods, their adaptive capacity, coping practice and ability to engage in sustainable forest use and management of climate change adaptation.

Design/methodology/approach – The paper opted for a desktop review approach, using the forest-based rural communities of South Africa as a case study.

Findings – This review shows that climate variability and change are affecting rural people and their livelihoods negatively. Forest-based livelihoods are particularly vulnerable. Nevertheless, the people have developed coping mechanisms to cushion the effects of climate variability and change. However, the effectiveness and efficiency of these strategies are greatly constrained by factors that are related mostly to their socioeconomic characteristics (for example, skill level, educational status and health) and the functionalities of infrastructures and services in their communities.

Research limitations/implications – Given that the study focused on forest-based rural communities and livelihoods, the results may be limited in generalizability. This may have particular implications for other categories of rural communities and livelihoods in Africa and developing countries in other continents.

Practical implications – The study showed that opportunities for planning and implementing effective climate change adaptation at rural community level in South Africa are reliant on effective strategies to overcome the constraints identified by the study. The authors thus recommend that climate change adaptation initiatives in rural communities of Africa should focus on improving people's socioeconomic conditions and the overall sustainable development of the community.

Originality/value – This paper fulfils an identified need to study how climate change affects rural forest-based communities and livelihoods.

Keywords Community, Forests, Livelihoods, Development, Adaptation

Paper type Literature review

The authors are grateful to the National Research Foundation of South Africa for funding this study through the innovation doctoral scholarship programme, Grant UID: 82942. The fund enabled the first author to undertake this research as part of his doctoral study.

1. Introduction

The reality of climate change is increasingly gaining acceptance in scientific and political communities (Dube and Phiri, 2013; Fisher *et al.*, 2010). The direct and indirect impacts of climate change are envisaged to have severe consequences for African societies and economies (Dube and Phiri, 2013; Somorin, 2010; Ajani *et al.*, 2013). Rural communities are believed to be particularly vulnerable to climate change (Dubois, 1999; Holmes, 2007; Turpie and Visser, 2013). This vulnerability of rural households in Africa is caused not only by exposure to climate change but also by a combination of social, economic and environmental factors that interact with it (David *et al.*, 2007). Therefore, by implication, climate change poses environmental, social and economic challenges for South African societies, particularly rural communities with high dependence on natural resources (Turpie and Visser, 2013; Fairbanks and Scholes, 1999).

The understanding of the vulnerability of rural communities has been a subject of concern over the years (Dlamini, 2014). The second assessment report of the Intergovernmental Panel on Climate Change (IPCC) conceptualized vulnerability as the impact on a system after a hazard event. This concept puts hazard at the centre of vulnerability analysis, focusing on biophysical drivers such as temperature, precipitation and extreme climatic events (Nelson and Agrawal, 2008). However, in recent years, there has been growing recognition that vulnerability is not only because of biophysical drivers, that is, the characteristics of the hazards, but is also a function of the system's sensitivity and adaptive capacity (Shah *et al.*, 2013). This evolution in the conceptualization of vulnerability has significant implications for our understanding of rural communities' vulnerability to climate change. As a step towards a comprehensive understanding of forest-based rural communities' vulnerability to climate change in South Africa, the authors provide a review of literature related to this concept. Although several studies have analysed the impact of climate change on local livelihoods (Chinara *et al.* 2013; Turpie *et al.*, 2002; Turpie and Visser, 2013), there is little literature that is dedicated to understanding the impact of climate change on forest-based livelihoods at rural community level in South Africa.

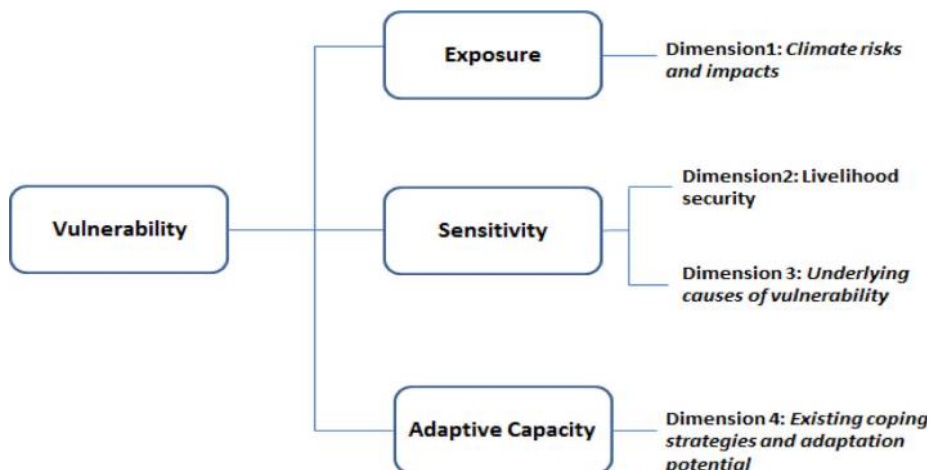
In this review, the authors view vulnerability as a function of the character, magnitude and rate of climate variation to which a community is exposed; the people's livelihood sensitivity; and their adaptive capacity (Adger *et al.*, 2007; Turner *et al.*, 2003). They expand the IPCC vulnerability assessment framework to four critical dimensions, namely, the climate risk and impacts to which a community is exposed; livelihood security; underlying causes of vulnerability; and existing coping strategies and adaptation potential. These are illustrated in Figure 1.

This paper is subsequently grouped in four sections. In each section, the findings and evidence from the literature are described. Section 1 discusses the exposure of forest-based rural communities to the risk of climate change. Section 2 examines the sensitivity of forest-based livelihoods and communities to the impact of climate change. Section 3 explicates existing coping strategies and adaptation potential at the rural community level. The concluding Section 4 summaries the finding from the three cases and makes appropriate recommendations.

2. Forest-based rural communities' exposure and susceptibility to the impacts of climate change

Climate variability and change challenges are expected to manifest in various forms, which include changes in rainfall pattern and regime, and in the frequency and severity of extreme weather events such as drought and flooding (Davis, 2011). The occurrence of these climatic events would vary in magnitude, frequency and duration across the country. However, the

Figure 1. Essential dimensions in vulnerability analysis



Source: Authors' own work

extent of their impact would depend largely on the socio-demographic characteristics of the communities (Davis *et al.*, 2010; Davidson *et al.*, 2004). Climate change impact on forest ecosystems and natural capital would almost certainly alter the economic and physical factors that determine their livelihood strategies and resilience (Chia *et al.*, 2013). Rural communities in South Africa are widely and differentially exposed to degrees and types of climate variability and extreme weather events.

In South Africa, climate change is predicted to result not only in higher temperatures but also in sporadic rainfall patterns and frequent droughts (Turpie and Visser, 2013). These severe weather events, coupled with the country's already scarce water resources, are expected to have a significant effect on the forestry and agricultural sectors, which are substantial components of the country's rural livelihoods and economies (Turpie and Visser, 2013; Quinn *et al.*, 2011). These trends have serious implications for water management in the country, particularly for regions that rely on large storage dams, which are sensitive to changes in rainfall, runoff and evaporation rates (DEAT, 2004). Although access to water in rural areas in the country has increased to 71 per cent since 2006, approximately 8.2 million people, who live mostly in rural areas, have inadequate or no access to piped water (DEA, 2011). In addition, many of the environmental and socioeconomic challenges that are affecting rural communities in South Africa are likely to be exacerbated by climate change (Chia *et al.*, 2013; Baez *et al.*, 2013).

Climate change manifestations in the form of rising temperatures, changes in water availability and increased levels of carbon dioxide are expected to affect farming and forest-based livelihoods in various ways (Sonwa *et al.*, 2012). Impacts facing the agricultural sector include a reduction in the amount of land that is suitable for arable and pastoral agriculture, a shortened growing season and a decrease in yields, particularly along the margins of semi-arid areas (Turpie *et al.*, 2002). Erratic rainfall is perceived to be a potential trigger of increased food insecurity and impoverishment in most communities that rely on rain-fed agriculture. South African rural communities are no exceptions, and this may eventually exacerbate poverty (DEA, 2011). Droughts and floods are recurring environmental challenges in several rural communities across the country (DEAT, 2004). In 2000, severe

floods affected northern South Africa, causing multiple deaths and severely damaging many infrastructures (David *et al.*, 2007; Linkd Environmental Services, 2013b).

In the case of forest-based livelihoods in rural communities, changes in temperature and rainfall patterns imply alterations to the structure and functionality of the forest ecosystems, which would have several implications for these communities (Fairbanks and Scholes, 1999; Kyei, 2011; Naidoo *et al.*, 2013). Increased frequency and intensity of forest fires would have severe consequences not only for rural communities dominated by commercial tree plantations but also the South African forestry sector, which contributes about 2 per cent of the country's gross domestic product (GDP) (Williamson *et al.*, 2005; Chamberlain *et al.*, 2005). According to FSA (2009), fire is one of the major risks that negatively affect the sustainability of plantation forests in South Africa. The Department of Water and Forestry (DWAF) (2009) reported that fires pose the highest risk to the sustainability of the forestry sector, with grave consequences for the well-being and livelihoods of rural households. It was similarly reported that about 579 to 728 ha of plantations were damaged by fires from 1980 to 2011 (DWAF, 2005; Rudzani and Amani, 2013). Changes in the intensity and incidence of fire are also likely to have strong indirect effects on rural communities, because of the importance of seasonal burns in maintaining savannah ecosystems and provisioning good grassland for livestock grazing (Turpie and Visser, 2013). Furthermore, Turpie *et al.* (2002) reported that climate change would probably significantly reduce areas suitable for plantation forests, which provide direct and indirect employment to between 200,000 and 260,000 people (about 1.4 per cent of a rural population of about 16 million) in the country (Chamberlain *et al.*, 2005).

The impacts of climate change on forest ecosystems would have serious implications for the country's nature conservation and tourism sector, a significant contributor to rural livelihood in most of the rural communities. The South African tourism sector has been estimated to contribute 10 per cent of national GDP (Turpie *et al.*, 2002). Overall, Turpie *et al.* (2002) anticipated that the effect of potential climate change on this sector would have serious negative consequences for rural livelihoods and it could lead to a decrease in tourism income, for which up to 3 per cent of GDP is at risk. In addition, the implications, for example, of increased temperatures for pests and pathogens that affect key species in natural and plantation forests are important areas of concern (Naidoo *et al.*, 2013).

In general, South Africa's forest-based rural communities are disproportionately exposed to risks of climate variability and change (Davis, 2011). The extent of the implications of these exposures remains uncertain, partly because of the uncertainties in climate change projections and insufficient understanding of forest ecosystem responses to changing climatic factors (Davis *et al.*, 2010; Davis, 2011).

3. Forest-based livelihood sensitivity to climate change impacts

In South Africa, as elsewhere in Africa, the majority of rural households and a large proportion of urban households depend on forest resources for subsistence and income generation (Chamberlain *et al.*, 2005; Dlamini, 2014; Sonwa *et al.*, 2012; Chaudhury *et al.*, 2011). The long-term contributions of forests and forest products to the livelihood strategies of the rural poor have long been appreciated (Salafsky and Wollenberg, 2000; Belcher *et al.*, 2015; Vedeld *et al.*, 2004; VBR, 2012). Climate change poses a risk to the composition and functionality of forest ecosystems (Locatelli *et al.*, 2010). South African forest ecosystems and forest-related sectors, however, are unevenly exposed to various types and magnitudes of climate-related hazards (Davis, 2011; Sonwa *et al.*, 2012). These are likely to disproportionately affect forest-based communities, depending on the people's livelihood strategies and the socio-demographic characteristics of their community (Wittman and

Caron, 2009; Tschakert, 2007). “Livelihoods” here refers to the ways in which people make a living (Somorin, 2010). Livelihood is at the heart of all studies that analyse the impact of climate change at rural community level in Africa (Tembo, 2013).

Forest-based livelihood strategies are influenced by forest type. Thus, differential vulnerability of forest types would have different implications for forest-based livelihood strategies (Sonwa *et al.*, 2012). Therefore, some livelihood strategies may incur more climate risk (Somorin, 2010). To a moderate extent, non-wood forest products are likely to be affected by the direct impact of climate change more than woody products (Wan *et al.*, 2011). However, woody and non-woody forest products are both vulnerable to direct and indirect impacts of climate change (Sonwa *et al.*, 2012). The ability of forest ecosystems to continuously provide goods and services that are vital for rural welfare and livelihoods is highly dependent on climatic conditions and human interference (IPCC, 2007; Sonwa *et al.*, 2012). In addition, climate change impact on the forest and agricultural sectors might have severe consequences on other sectors of rural economy that are either directly or indirectly linked to the forestry sector. Thus, volatility in one sector may cause other sectors to be highly unpredictable through backward and forward linkages (Birkmann, 2008).

3.1 Factors influencing vulnerability of forest-based communities to climate change

The vulnerability of forest-based rural communities is not related merely to the direct and indirect effects of climate variability and change (Quinn *et al.*, 2011). Complex interrelations between forest and human systems imply that the susceptibility of one system could lead to the sensitivity of others (Osbahe *et al.*, 2010; Isaacs and Mohamed, 2000; Shah *et al.*, 2013; Linkd Environmental Services, 2013a). As observed by Tschakert (2007), poor socioeconomic development and weak infrastructures and facilities can lead to unsustainable local forest use and management practices, resulting in the vulnerability of forest ecosystems and associated livelihood strategies.

The vulnerability of households to climate risk may be linked closely to socioeconomic conditions, which correlate with the people’s adaptive capacity (David *et al.*, 2007). Although South Africa has experienced long-term urbanization, almost 39 per cent of the country’s population currently live in rural areas (Linkd Environmental Services, 2013a). The overwhelming majority of the rural population are poor and reliant on social grants, remittances from urban areas and farming- and forest-based livelihood strategies (Linkd Environmental Services, 2013b; Turpie and Visser, 2013). Owing to their geo-climatic conditions, forest-based rural communities in South Africa are also faced with a high degree of socioeconomic vulnerability, making them susceptible to climate risk. Poor socioeconomic conditions can reduce the ability of households to deal with climate risks, shocks and stresses (Shah *et al.*, 2013). Socioeconomic conditions that make households in forest-based communities prone to climate change are elaborated in this section.

3.1.1 High dependence on forest resources. Most rural communities in South Africa are typically underdeveloped in terms of infrastructure, provisioning of government services and employment opportunities, and are consequently highly dependent on forest resources for income and subsistence (Naidoo *et al.*, 2013; Turpie and Visser, 2013). In addition, dependence on climate-sensitive forest resources and livelihood activities such as rain-fed agricultural practices makes these communities susceptible to climate variability and change. Moreover, current processes of forest resource exploitation and utilization in these communities are unsustainable, which is evident in the growing rates of deforestation and forest degradation. In addition, deforestation and forest degradation are now at such a scale that they are a major threat to economic development and progress in rural well-being. As reported by Robledo *et al.* (2012), households that are highly dependent on earnings from

forests, subsistence rain-fed farming and livestock rearing are exposed to climate change risk. Fisher *et al.* (2010) observed that households that are most reliant on forests have low income per person, are located close to forests, are more risk-averse, are less educated and thus have low adaptive capacity to climate change.

3.1.2 Unemployment and poverty. Rural household incomes are constrained mostly because rural economies are not sufficiently vibrant to provide the people with remunerative jobs. Consequently, most rural communities are characterized by high poverty levels (Naidoo *et al.*, 2013). Furthermore, 69 per cent of all South Africans that live in poverty are located in rural areas (Barjis *et al.*, 2013), which are characterized by multiple stresses such as high unemployment and low economic development opportunities (VBR, 2012; Madzwamuse, 2014). Lack of or poor employment opportunities in rural areas often cause people to engage in seasonal income-generating activities, informal trade in agricultural and forest products and over-dependence on governmental support, for example, social grants (Barjis *et al.*, 2013; Naidoo *et al.*, 2013). These often lead to perpetuation of poverty in the rural areas, thereby weakening people's capacity to respond to climate and socioeconomic challenges (Dube and Phiri, 2013; Turpie and Visser, 2013).

3.1.3 Population pressures. Population pressure is another factor that contributes to the low capacity of rural communities to cope with adverse effects of climate change. South Africa's rural population grew by 1.4 per cent in 2012 (Barjis *et al.*, 2013). It is not surprising that in South Africa today, forest conservation areas and forest resources are under threat from population pressure and systems of land use in many rural communities (Turpie and Visser, 2013). Population growth in rural communities has created an imbalance between population density and available facilities and infrastructure, which has amplified the people's vulnerability to climate change (Turpie and Visser, 2013). With increasing populations, there is higher demand for harvesting of forest resources and for clearing of new farmland. In addition, more than 85 per cent of the lands in rural areas are settled by commercial farmers, which also limits land availability to rural households for subsistence farming (Madzwamuse, 2014). All these factors lead to increased land degradation, thus reinforcing vulnerability to climate change (Calzadilla *et al.*, 2009).

3.1.4 Poor healthcare service facilities. Despite recent improvements in access to healthcare facilities in South Africa, imbalances in the coverage of health services persist (Tansera *et al.*, 2006). Many rural communities still have poor access to healthcare facilities and rural hospitals and clinics are often poorly equipped and understaffed (Barjis *et al.*, 2013; Madzwamuse, 2014). Most local communities do not have the medical facilities and infrastructure to handle the outbreak of disease. Many depend on traditional medical methods, which may not be effective in addressing new diseases and infections. Inhabitants of rural communities often travel long distances to visit clinics and hospitals. As reported by Tansera *et al.* (2006), proximity is an important factor that affects health outcomes and adaptive capacity of households in rural South Africa. In addition, many rural households are struggling with the HIV/AIDS pandemic and may have to battle with an additional stressor of climate change (Madzwamuse, 2014). Hosegood *et al.* (2007) observed that households in which multiple adult deaths have occurred in the past two years are at higher risk of dissolution, migration and reduced economic status. The status of healthcare facilities in many rural communities, coupled with people's socioeconomic conditions, could constrain proper well-being and rural development. The result would probably be heightened vulnerability to climate change.

3.1.5 Inadequate formal skills. Most rural people in South Africa have limited education and inadequate skills to engage in alternative sustainable off-farm and off-forestry income-generating activities. This leads to most community members depending on forest activities

such as the collection of firewood and other forest products, and the production of charcoal, which in turn lead to forest degradation.

3.1.6 Inadequate skills and capacity for forest management. Effective adaptation to climate change can take place only when there is adequate capacity in terms of knowledge, information, infrastructure and skills, enabling policies and strategies at various levels including at grassroots for sustainable forest management. One of the major contributors to the vulnerability of rural communities is inadequate capacity and institutional support for sustainable community forest management (Hachileka, 2009). Most rural communities have limited access to markets, credit opportunities and formal education (David *et al.*, 2007) with few resources at their disposal and limited access to quality social services, and most of the community tend to be vulnerable when natural and anthropogenic hazards occur.

4. Existing coping strategies and adaptation potential

Responding to climate change at rural community level in South Africa is a major development challenge, which is considered in the context of wider development pressures, which includes poverty and sustainable management of forest and land resources (Lemos *et al.*, 2013; Arnall, 2012). Rural households, however, have been observed to use various coping strategies in response to climate change-induced environmental challenges (Arnall, 2012). However, as reported by Arnall (2012), their traditional coping mechanisms might not be sufficient to deal with the new challenges brought about by climate change.

The evidence indicates that communities in South Africa and Africa in general have adopted various coping mechanisms. From traditional practice to modern procedures, communities have used various strategies to deal with the effects of climate variability and change (Chigavazira, 2012). Several researchers have reported the strategic role of indigenous knowledge and utilization of natural resources such as non-timber forest products in rural households' coping strategies in Africa (Locatelli *et al.*, 2010; Pramova *et al.*, 2012; Shackleton *et al.*, 2008; Wilk *et al.*, 2013; Valdivia *et al.*, 2005). In the same vein, households often switch to cultivating drought-tolerant crops in coping with drought and erratic rainfall.

For example, Chigavazira (2012) observed that small-scale farmers in Dzindi community in the province of Limpopo, South Africa, used a variety of strategies to handle climate variability and change. These include irrigating, and switching from maize cultivation to sorghum, a more drought-resistant crop. Thus, Gbetibouo (2009), in a study of adaptation practices used by farmers in the Limpopo basin, observed that farmers' main adaptation practice entailed switching to more drought-tolerant crops, such as millet, and to different varieties of the same crop, such as more drought-tolerant maize.

Other adaptation practices used by rural households included changing planting dates, increasing irrigation, harvesting water, buying livestock feed supplements, planting and retaining trees on farms and around homes and selling livestock (Bryan *et al.*, 2010). However, despite widespread adoption of coping practices at community level, the evidence shows that people do not always respond in the same manner to similar climatic stimuli. As noted by Bryan *et al.* (2009), farmers' responses to the same climate stimulus often vary, even in the same geographic area.

4.1 Determinants of adaptation

While a range of coping strategies used by households (Gbetibouo, 2009; Valdivia *et al.*, 2005) have been identified, there is equally need to understand factors that drive households to adopt these strategies. This understanding would provide further awareness of ways in

which to develop appropriate adaptation programmes for household livelihood resilience and sustainable rural development (Baez *et al.*, 2013).

Several factors influence people's decisions to adjust their livelihood strategies in response to climate variability and change. Berman *et al.* (2013), Adeniji-Oloukoi *et al.* (2013) and Chigavazira (2012) observed a correlation between population socioeconomic characteristics and adoption of coping strategies. For example, Berman *et al.* (2013) reported that access to resources, credit and agricultural extension services and behavioural factors such as risk perception are core elements that influence a household's choice of coping strategy. Similarly, Bryan *et al.* (2009) and Gbetibouo (2009) noted that entrepreneurial capacity and prevailing market systems have effects on households' choice of coping strategy. For example, markets for millet were found to influence people's choice of millet cultivation as a preferred drought-resistant crop in coping with climate change (Bryan *et al.*, 2009).

4.2 Constraints to adaptation

Factors that influence household choices of coping strategy and coping capacity can sometimes be a constraint to adaptation. For example, access to credit was reported as the major constraint to coping and adapting at rural community level in several African countries (Tembo, 2013; Chigavazira, 2012; Bryan *et al.*, 2010). In the same vein, Bryan *et al.* (2010) observed that social support programmes sometimes hinder the adoption of coping strategies. For example, access to food emergency relief was shown to negatively influence the decision to plant trees as a coping strategy in Kenya. Similarly, Berman *et al.* (2013) and Quinn *et al.* (2011) reported lack of technical knowledge and of access to markets as major constraints to adoption of coping strategies at rural community level. For example, in regions where only maize is eaten, lack of markets for sorghum might limit the adoption of sorghum cultivation as a drought-resistant plant. In addition, lack of technical knowledge of and expertise in processing and consuming the new product could be limiting factors. Other commonly reported constraints include lack of information, lack of access to land and lack of access to inputs.

5. Conclusion

This review has considered the real and imminent impacts of climate change on South African forest-based rural communities. The discussions have highlighted the potential of forest use and management to reduce or increase the vulnerability of rural households to climate change. Although households use a range of measures to manage risks and shocks associated with climate variability and change, these coping and adaptation practices are often insufficient to maintain resilient sustainable development and household welfare in the face of climate shocks. An important and encouraging finding from this study is that the effectiveness and efficiency with which households adopt a coping practice is strongly linked to their socioeconomic and demographic characteristics. This implies that adaptation programmes that improve households' socio-demographic condition might be effective in improving rural communities' resilience to climate change challenges.

A critical challenge that adaptation initiatives may have to deal with in these communities will be how to ensure that individuals and communities are able to sustain their adaptation after adaptation intervention has ended. To this end, an understanding of the linkages between exposure to climate risk, household coping practices and adaptive capacity is imperative. The study revelation on how issues such as poor forest use and management capacity, poverty, unemployment, population growth and poor healthcare service facilities underlies rural communities' vulnerability to climate change and therefore

present an important insight for resilience building. Incorporating these issues when designing adaptation programme would help in guiding against maladaptation. This will help in target enhancement of the functionality of available assets, institutions and facilities for improvement of individual and community resilience and adaptive capacity.

Based on these submissions, the following recommendations are made for improvement of household's resilience and adaptive capacity to challenges of climate change in South Africa's forest-based rural communities:

- It is vital to build capacity at rural community level for sustainable forest management, implementation and sustenance of adaptation programmes.
- Given that unsustainable forest use and farming practices are salient factors that influence the vulnerability of forest ecosystems and rural communities to climate change, promoting sustainable forest use and management should pervade all adaptation strategies and policy options at rural community level.

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