VIETNAM'S CENTRAL HIGHLANDS' UPLAND AGRICULTURE UNDER PRESSURE BECAUSE OF THE LOOMING EFFECTS OF CLIMATE CHANGE – FOCUS ON ROBUSTA COFFEE

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- *By 2025 a global coffee shortage equivalent to 1.4 times the current production of Vietnam – the world's largest Robusta coffee producer – is expected. On a parallel scale upland agriculture and in particular coffee production is under pressure because of the looming effects of climate change.*
- *This briefing paper aims to awaken awareness at all levels in the coffee supply chain and representatives in charge of upland agriculture.*

Climate Change to Disrupt Global Coffee Supply?

In recent years there has been a surge of studies that model how the climate may change in the future. However, very few studies have looked at what might be learnt from how the climate has already changed during the past few decades – the rate of change, the geographical variation and how the changes might relate to production of upland crops such as coffee.

Yet there are increasing signs that governments, companies and individuals are underestimating the rate at which climate risks are increasing for agriculture and other industries. This, while recent events in Colombia, Central America, Brazil, Indonesia and other places suggest that climate change is already negatively affecting coffee production. Additionally, global demand for coffee is increasing. Up to 38 million additional bags (60 kg) of coffee – equivalent to 27% of the current global production – will be required by 2025[i].

Vietnam is the world's leading Robusta coffee producer (20% of global production) and coffee is the second largest export-earning crop, supporting the rural livelihoods of over 2 million people. Export volumes of 27-28 million bags were reported in 2015 generating revenues over 3 billion USD. Robusta coffee covers as much as 15% of Vietnam's Central Highlands, making it the most intensive and concentrated area of coffee production in the world. Most coffee is produced by smallholders (average 1 ha) as an un-shaded and clean-weeded mono crop. Since the dry season lasts approximately 5 months (mid-November to mid-April) irrigation is a pre-requisite to boost flowering and achieve economically viable yields up to 4 Mt per ha. Despite the relevance of Vietnam's Central Highlands for global coffee supply, climatic and environmental data for this zone however is scant and wholly incommensurate with its importance.

Hence the purpose of this study is to examine the available data to determine the extent to which the climate of this greatly transformed zone may have already changed. The main rationale is to discover if recent trends can inform practitioners to help develop effective adaptive strategies.

Central Highlands Warming Faster than Earth's Average

Earth's average temperature has risen by about 0.85°C for the period 1880–2015[ii], but such figures are misleading for agriculture because they are land + sea means. Over the past 40 years, Vietnam land temperatures have warmed by 0.26°C per decade with dry season temperatures rising 25 to 40% more than wet season[iii].

A Hanoi University of Science study commissioned by c&c[iv] found, for the period 1979-2012, a 0.3-0.5°C per decade increase of mean temperature for Central Highlands in November, December and February, a tiny decrease of 0.05°C per decade in March and April - explicable as a consequence of earlier rains as explained in the next chapter - and an increase of 0.1-0.4°C per decade in the other months (Figure 1).

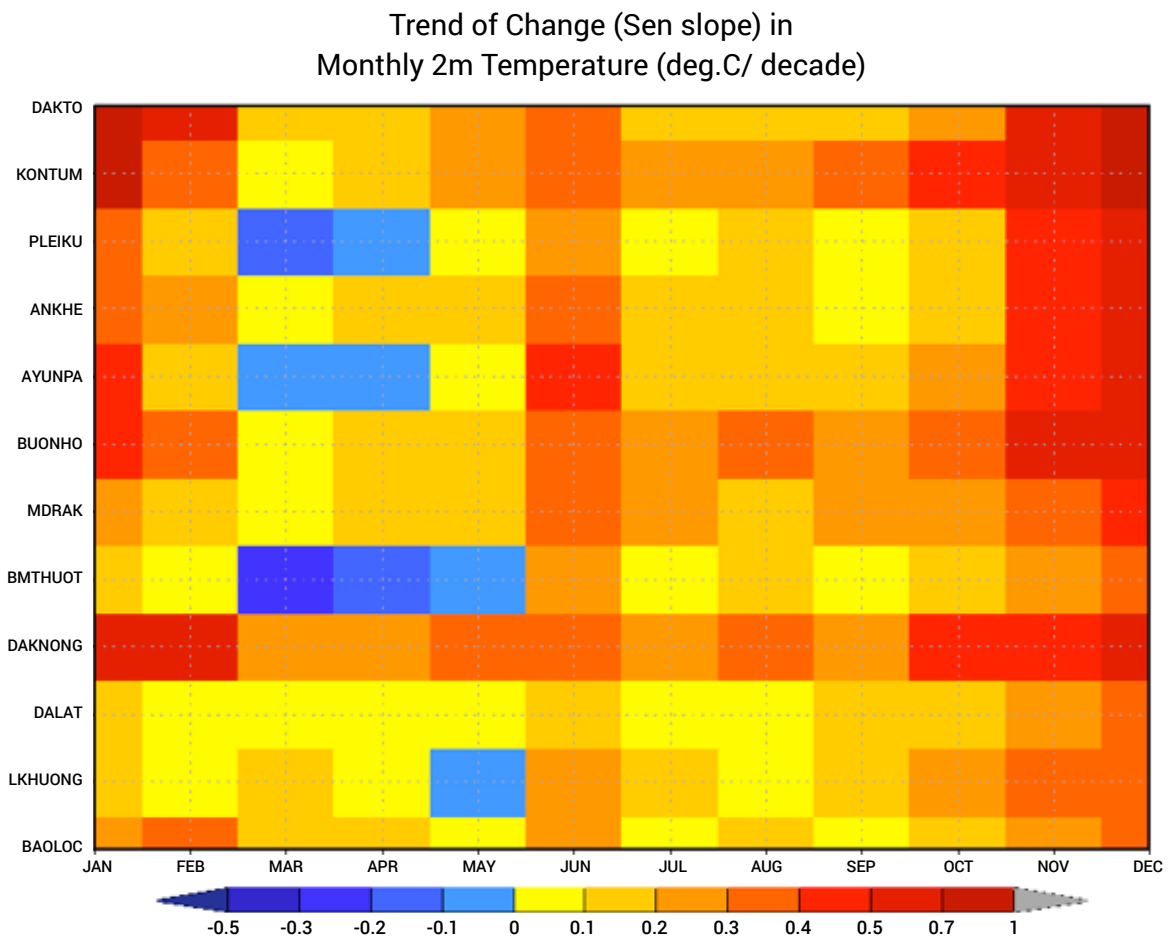


Figure 1: *Trend (°C/decade) of monthly mean temperature of Central Highlands stations (listed N to S)*

It is mostly minimum temperatures that have risen, by 0.2 to 0.6°C per decade whereas maximum temperatures have actually fallen in some localities, especially in the southern Central Highlands. This may relate to cloudier afternoons, stronger wind speeds, changes in atmosphere moisture content or increased continent-wide air pollution from major industry centers. This situation contrasts strongly with the period 1960 – 1980, where there were very rapid maximum temperature increases[v]. The Central Highlands' diurnal temperature range has significantly decreased by up to -0.64°C per decade.

The Rainy Season on the Move

Total Central Highlands' rainfall has increased since 1960 but there is wide variation and no clear intra-regional trends. Since 1979 however, rainfall has increased in March, April, July, September, November and December but decreased in January, February, June, October (Figure 2). Some of these changes are quite marked[vi]. This has led to a surprising effect: both onset and end dates of the rainy season have been starting earlier, by 2 to 4 days per decade, the reason for which is not understood.

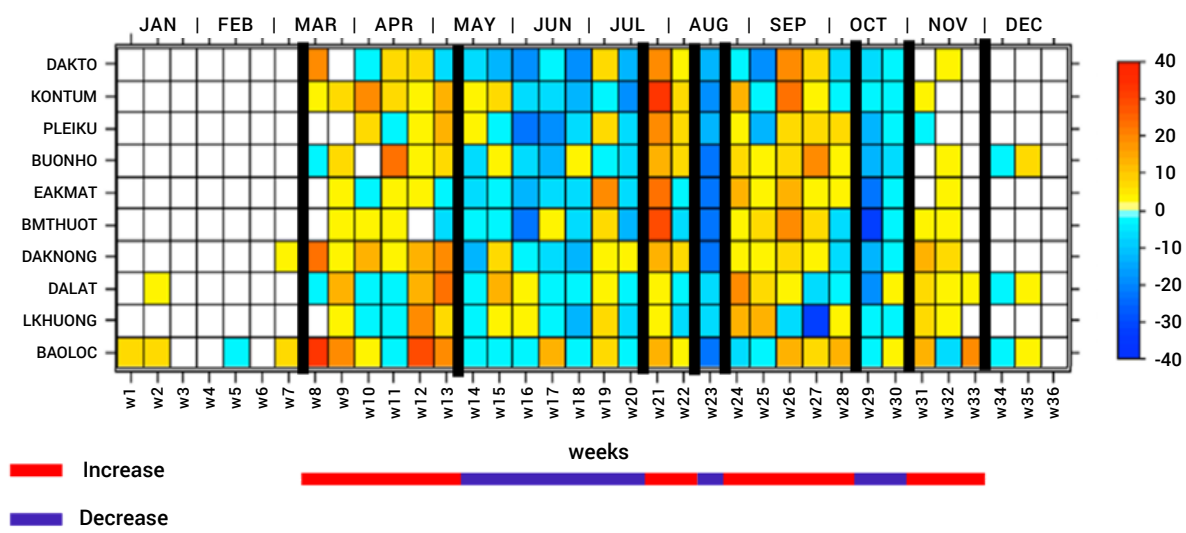
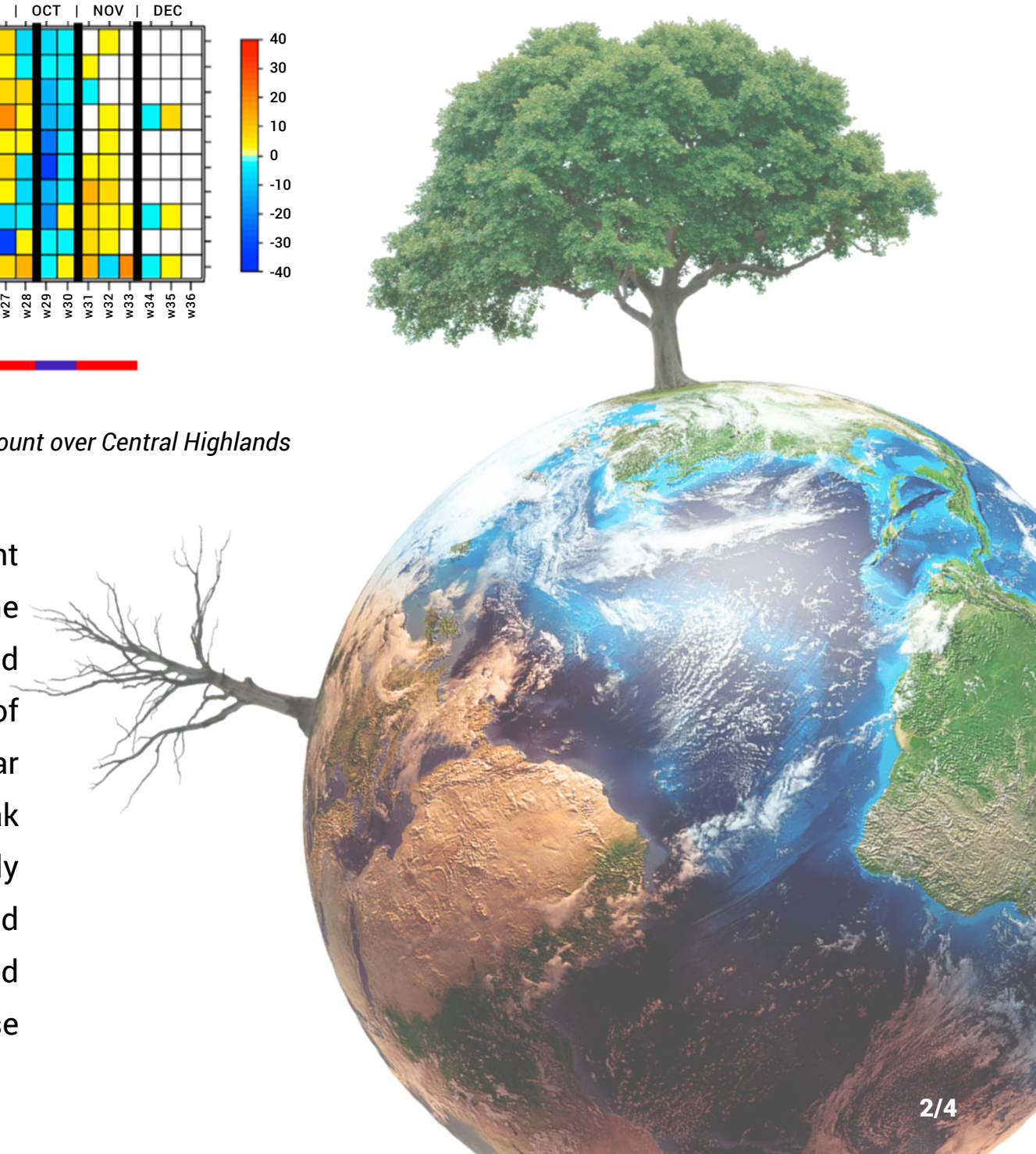


Figure 2: *Decadal percentage changes in weekly rainfall amount over Central Highlands during 1981-2014 period*

Usually there are 4 to 7 periods of intermittent rain during the wet season; neither the frequency nor intensity of these has changed significantly in recent decades. The number of rainy days in the dry season shows a clear increasing trend, especially at stations in Dak Lak; this is reflected too in the greater monthly total rainfall for March, April, November and December. Severe droughts are mostly linked to El Niño events and it is very likely that these will cause greater variability in the future[vii].



Coffee Trees and Their Custodians Suffering

It is expected that an increased number of wet weather outbreaks will occur in the dry season in south Central Highlands which is likely to affect flowering patterns.

Diurnal temperature change i.e. higher minima and less change in maxima leads to a reduced diurnal range. This is very likely to favour some pests and diseases. For example, fungal diseases mostly prefer a 'not-too-hot; not-too-cool' regime that reduces likelihood of drying out and low temperature inhibition of the delicate germination process. On top of this, higher average temperatures mean that insects like the coffee berry borer may be able to complete an extra life-cycle and therefore exert greater economic loss. Higher temperatures may also stress the trees – it is well-established that many insects find it easier to overcome the defenses of weakened trees. For example cicadas have become abundant in the Central Highlands in recent years; a possible reason for this is that they find it easier to attack trees stressed by drought and/or higher temperatures. Last but not least, increasing temperatures, together with high fertilizer use, may accelerate the breakdown of organic matter and provoke changes in the microbial balance of the soil which may affect a range of 'friendly' microbes that tend to control soil pests and diseases such as nematodes and mealybugs.

Climate variable	Tendency	Variation	Potential effect on coffee
Minimum temperature	↗	∿∿∿	Pest and disease increases
Max temperature	→	∿∿∿	
Diurnal temperature range	↘	∿∿∿	Pest and disease increases
Total annual rainfall	→	∿∿	Increased variation makes planning farm work and coffee drying more difficult
Length of wet season	→	∿∿∿	
Heavy rain	↗	∿∿	Possible effects on flowering and tree damage
Continuous dry days (CDD)	↘	∿∿∿	
Continuous wet days (CWD)	↘	∿∿∿	
Outbreaks of wet weather in the dry season (ORD)	Mixed	∿∿∿	Potential inhibition of pollination after flowering
1-week Palmer drought severity index	→	∿∿	
Other drought severity indices	Mixed	∿∿∿	

Policy Recommendations

Monitoring and research: given that the Central Highlands climate is definitely changing, but in quite complex and heterogeneous ways across the region, it would be important to:

- Greatly extend the number of meteorological measurement points, to get a much better understanding of local climate change as it may relate to local land use change. Modern miniaturized measurement recording devices are quite inexpensive, so a large number could be deployed to gain a much better idea of local climate change.
- Early warning: year-to-year variations of the onset dates and the rainfall amount within the rainy season and summer monsoon season are closely linked with the preceding winter and spring sea surface temperature in the central-eastern and western Pacific. This suggests that there is some scope to develop early warning advice to farmers.
- Carry out detailed studies with satellite data to observe rainfall and temperature changes and where possible to relate these to land use change.
- Determine the extent to which coffee differs from forest in terms of evapotranspiration and how it compares with other crops such as rubber. More generally it is recommended to create a comprehensive understanding of the changing hydrology of the Central Highlands.
- Climate change will very likely increase some pest and diseases, including new or previously rare ones. It would be advisable therefore to carry out routine pest and disease surveys, so as to detect changes in a timely fashion.

The above recommendations are aligned with Vietnam's statement presented at the UNFCCC in 2016[viii].

Farmers: climate change is poorly understood by farmers and other rural stakeholders. It is suggested that training curricula should include teachings on climate change and the effects of land use change and what this means for present and future production challenges.

Traders: coffee buyers have very detailed knowledge of coffee production in a particular district as well as information about recent weather-related production problems (e.g. poor quality through cherry drying difficulties, flood damage, etc.). They are therefore a potentially valuable source of information and early warning of difficulties. Hence ways to tap into this knowledge should be considered.

Government: The Central Highlands region is a vitally important strategic production and eco-service resource to the nation; there is now enough evidence to suggest that there are significant climate changes taking place. A strategic plan is needed that covers research, enhanced routine monitoring, widespread adaptation implementation and comprehensive training.

This briefing paper summarizes major research findings from more detailed reports "Climate Change Assessment for Risk Management of Hydro-meteorological Disasters in Coffee Cultivation and Trading in the Vietnam Central Highlands" and "Variations and Changes in Rainfall and Drought in the Central Highlands, Vietnam" by Prof. Phan Van Tan (2013 & 2016) and the discussion paper "Coffee and climate change in the Central Highlands of Vietnam" by Dr. Peter Baker (2016). This research was funded by the Initiative for Coffee and Climate (http://www.coffeeandclimate.org).

[i] Neumann Kaffee Gruppe, Statistical Unit, 2016.

[ii] http://climate.nasa.gov/vital-signs/global-temperature/

[iii] Nguyen, D. Q., Renwick, J., & McGregor, J. (2014). Variations of surface temperature and rainfall in Vietnam from 1971 to 2010. International Journal of Climatology, 34(1), 249-264.

[iv] Phan Van Tan, Ngo Duc Thanh, Nguyen Van Hiep, (2013). Climate Change Assessment for Risk Management of Hydro-meteorological Disasters in Coffee Cultivation and Trading in the Vietnam Central Highlands. Initiative for coffee & climate, unpublished report 65pp.

[v] Ho Thi Minh Ha, Phan Van Tan, Le Nhu Quan, Nguyen Quang Trung (2011). Extreme climatic events over Vietnam from observational data and RegCM3 projections. Clim Res, 49, 87-100.

[vi] Phan Van Tan, Nguyen Van Hiep, Ngo Duc Thanh (2016). Variations and changes in rainfall and drought in the Central Highlands, Vietnam (2016). Initiative for coffee & climate, unpublished report 56pp.

[vii] Stocker, T. F. (Ed.). (2014). Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the IPCC; chapter 14. Cambridge University Press.

[viii] Statement by Viet Nam at the UNFCCC SBSTA 44 in-session workshop on agriculture, 20 May 2016, Bonn, Germany; Experience with the identification of adaptation measures in the context of agriculture.