Physical Climate Risk and Vulnerability Assessment

India Analysis

Executive Summary

FORUM FOR THE FUTURE

COTTON 2040

ACCLIMATISE
building climate resilience
Willis Towers Watson

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FOREWORD

Welcome to the **India Climate Risk and Vulnerability Assessment** report, which focuses on the climate risks to cotton growing and production in India. This work was completed by Acclimatise, in partnership with international sustainability non-profit Forum for the Future, as part of the Cotton 2040 initiative, funded by Laudes Foundation. This detailed report by Cotton 2040, is complemented by a broad Global report alongside a microsite with additional resources. Both are generated in response to the lack of comprehensive, readily available information about how the climate crisis is likely to impact cotton production, its supply chain, and the nature of the industry over the coming decades.

The Cotton 2040 initiative was originally established to bring together existing initiatives to align around critical issues for - and accelerate the transition to - long term sustainability. In the context of climate breakdown, this goes beyond standards, certification or corporate commitments. Whether adequately prepared or not, the cotton system will be forced to change in the face of the dramatic changes that our warming climate will catalyse. With this report, our intention is to offer this data and analysis to spark a dialogue that will lead to joined up, informed and responsible action, and resilient responses that are deliberate, collaborative and systemic.

The cotton industry, like many others, is unprepared for the changes that the growing climate crisis is bringing. Already, the sector is hard-pressed to address deeply entrenched environmental, social and economic challenges[1] across its supply chains. As this report amply demonstrates, these pre-existing vulnerabilities and inequalities will be exacerbated and accelerated by a warming climate. In other words, those actors and elements of the value chain that are already vulnerable will come under even greater pressure, and suffer increasing stress.

The cotton industry, like many others, is unprepared for the changes that the growing climate crisis is bringing.

While the focus of this report starts with the physical impacts of climate breakdown, what emerges is the interrelationship between climate risk and climate vulnerability.

Most industry-wide conversations and plans don't begin to address the scale of change that the climate crisis, if it continues on its current course (and even if ambitious steps are taken now), will force upon the industry, and the world.

India, as the world's highest cotton producing region, faces particular challenges that this report covers in detail. Climate threats will have profound effects, and in many cases present enormous difficulties for farmers and other actors across the value chain. These impacts will require a response that goes beyond incremental solutions to fundamental changes. We need to radically rethink where, how and why cotton is produced and traded, and what the future holds for this economically and culturally important fibre.

This is not just a theoretical exercise for the future. Change is not just on the horizon, it's happening now. In India there is already a clear pattern of an increasing number of days over 40°C, and changes to the monsoon patterns are resulting in the extremes of floods and droughts. The trend towards increasing unpredictability and volatility of weather events is already in play. We are on the pathway to a different world, and the changes will only accelerate.

While the focus of this report starts with the physical impacts of climate breakdown, what emerges is the interrelationship between climate risk and climate vulnerability. The risks posed by a changing climate will, like the COVID-19 pandemic, expose and deepen pre-existing vulnerabilities and inequalities. In an already polarised society, the effects of climate change are likely to exacerbate gaps and tensions, straining the fabric of society and putting increasing pressure on already fragile supply chains. These converging risks, that span climate, livelihoods, economics, politics and security, demonstrate the deeply systemic threat that climate change poses. The effects of climate breakdown on cotton in India alone will have effects all across the global supply chain.

A systemic threat requires systemic solutions. In considering the impacts of climate change, it is critical to emphasise that if we are to develop an adequate response, our focus needs to look well beyond understanding the changes in the weather. We need to find ways to build environmental and social resilience into supply chains, and also halt the downward spiral of the most vulnerable which will cost humanity and society so much more over time. Humanitarian crises have clearly demonstrated the economic argument for investing in resilience to avoid greater costs in responding to disasters.[2]

Both environmental and social impacts of climate change will affect the entire cotton value chain and cannot be tackled in isolation. The information in this report needs to be considered not just for the changing environmental context for cotton production and processing in India, but for how the impacts of climate will affect actors all along the supply chain. There are darker possibilities to factor in, such as the likelihood of societal disruption fuelled by resource scarcity or unequal distribution, leading to conflict or even war. All of this will have impacts not just on production, but transportation and distribution of goods, and beyond. The assumptions on which current supply chains are based cannot be assumed as a viable or predictable part of the future.

We urge people and organisations involved in the cotton industry to use this data and analysis to think radically about the future of cotton. No brand, retailer or trader will be able to avoid climate risk exposure in its supply chain; organisations must responsibly decarbonise their operations and supply chain impacts globally as quickly as possible, and centre climate impacts in their sourcing strategies. But we particularly call for the report to be used as a collaborative resource to make decisions together about how the industry needs to work, from how cotton is produced, transported, and used; to strategies, business models, financing and more. We offer this report as a tool to inform thinking, and action, about mitigation as well as adaptation. The information it presents calls for nothing less than a collective reimagination and transformation of the cotton value chain to be sustainable, resilient and just.

Charlene Collison and Hannah Pathak,
Forum for the Future

1 RATIONALE

1.1 | Why consider the impacts of climate change on India's cotton value chain?

The world has warmed by approximately 1°C since the pre-industrial era (1880-1900)[3] and future changes to the global climate system will continue to intensify over the coming decades.[4] Despite the ambitious goal as set out by the Paris Agreement[5] to keep global warming "under 2°C by 2050", to date, even the ambitious pledges and targets of countries around the world will only limit warming to between 2.2-3.4°C.[6] As it stands, current emissions reduction and climate change commitments and targets are being missed by the majority of countries, meaning that warming of more than 3°C is probable by the end of this century. However successful we are with decarbonisation, we are faced with decades of unavoidable climate change.[7] Preparing today for the changes that will occur tomorrow is essential if we are to limit the impacts of climate change on society.

These impacts continue to be unequal in different parts of the world, largely depending on the extent of their vulnerabilities. India - with its diverse geographical features, socio-economic conditions and a large proportion of population dependent on agriculture and natural resources for sustenance - is exceptionally prone to the large scale risks posed by climate change. According to the Global Climate Risk Index, 2019, India ranks 14th in terms of weather related losses and future climate risks.[8] The Fifth Assessment Report of the International Governmental Panel of Climate Change (IPPC) states that for India[9]:

- Temperatures may increase by 1.7-2.2°C by the 2030s as compared to the 1970s with increase in maximum temperatures, especially in coastal regions;
- Precipitation patterns will shift significantly;
- Extreme events such as cyclones will increase in intensity;
- Floods and droughts will become more frequent due to shifts in monsoon patterns; and
- Yields of major crops such as rice and sorghum are projected to decline.

These in turn will have a cascading impact on human and natural systems. Increasing temperatures will cause heat waves, rendering the majority of the country's population highly vulnerable to heat related health hazards. People and ecosystems across coastlines will be highly vulnerable to extreme events and sea level rise. The socio-economically vulnerable and marginalised sections of the population, especially women and children, will be at a much higher risk due to their inability to adapt to such shifts or bounce back in the face of disasters and economic loss. Decline in agricultural productivity will have knock on effects on food security and livelihoods of close to half of the country's population. The threat that climate change poses to development and economic security calls for urgent action to help human and natural systems adequately adapt to these changes. This becomes especially imperative in the context of the IPCC Special Report which states that a cap of 2°C rise in global temperature by 2100 will cause irrevocable losses and much higher risks than those anticipated before.[10]

1.2 | Why does the cotton value chain need to consider climate impacts?

Climate change can cause direct damage to cotton crop either through gradual, incremental changes, such as atmospheric warming or changes in total rainfall, or through sudden changes and extreme weather events such as flooding, hailstorms or heatwaves.

When cotton crops are damaged due to increases in temperature or climate-induced pest attacks, this results in a higher cost of production per hectare for the cotton farmer. This in turn results in indirect impacts including, lower expenditures on food and health and education for poorer, small-holder cotton farmers, which ultimately pushes those rural households towards, or further below, the poverty line.

Climate change can also cause direct impacts further down the value chain as a decrease in water availability due to a drying climate increases pressures on water-intensive activities chain such as dyeing, particularly in northern India. Indirect impacts on cotton processing units may include: uncomfortable working conditions in mills due to increase in temperature; increase in demand of imported cotton for ginning and spinning units due to crop failures; poor quality cotton and closing of small units and job loss due to decrease in domestic cotton production; and the requirement to compete with international markets for purchasing raw cotton.

Whether climate change impacts the cotton cultivation or the cotton processing aspects of the value chain, directly or indirectly, there are knock on impacts on the rest of the value chain with ripples felt across state-level, national-level and international-level cotton value chain and markets, and across the garment manufacturing, the retail and the consumption stages.

It is therefore essential that the profound changes in the climate and the impacts that they will have on the cotton value chain (CVC), the textile industry and more broadly the global cotton market are explored, and measures taken to mitigate these.

1.3 | Why was the initial focus on India?

India is the second highest cotton producing country in the world (as of 2019)[11] therefore any significant impact to cotton production in this country is likely to have an impact on the international supply of cotton, cotton-based textiles and apparel. Agriculture is one of the most important sectors in the Indian economy, a source of livelihood for around 50% of the population and contributing approximately 16% to India's GDP.[12] However agriculture is also one of the most climate sensitive sectors and extremely vulnerable to climate change. India's Economic Survey 2017-18 states that climate change could reduce annual agricultural incomes by 15-18% on average, and up to 20-25% for unirrigated areas.[13]

Impacts of a changing climate are already being observed directly on the cotton crop itself, on the start and duration of the growing season, and indirectly on the rest of the value chain. Farmers are already adapting to this change. For example, in 2009, extreme rainfall and flooding across Punjab submerged cotton fields under 1.2 - 1.5m of water, saturating the soil for months. Due to a repeat of the disaster in 2011, farmers in Sri Muktsar Sahib decided to divert away from cotton and towards planting rice paddy instead.

Furthermore, the textile industry contributes 5% of India's GDP.[14] Given the contribution of the sector, any adverse impact on cotton crops has implications for the business operation of textile manufacturers, and in turn, for the national economy.

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2 OBJECTIVES AND METHODOLOGY

2.1 | What is this study's unique value?

Following a thorough literature review, this pilot study addresses the gaps identified in the existing literature by providing an in-depth analysis of physical climate risks and socio-economic vulnerabilities to the majority of the CVC with specific focus on India.

This is done by using the latest methodology for assessing climate risk as set out by the IPCC[15], and using the latest, internationally-recognised climate projections from an ensemble of global circulation models[16] to capture an array of various climate hazards projected for the 2040s. A 20-year climatology is used spanning 2031-2050 to capture the 2040s. What makes the pilot study unique is that not only does it consider a plethora of climate hazards rarely considered in the literature (including the change in the growing seasons, damaging wind speed above a certain threshold, relative humidity, wildfire and more) but that these hazards include thresholds which are specific to cotton, for example, the number of days in a given year when temperatures exceed the upper temperature threshold tolerance at which a cotton plant can survive, i.e., ~40°C.

A total of 41 climate hazard indicators and socio-economic indicators are amalgamated into a single climate risk score. This enables the report user to identify the district at greatest overall risk from climate change. The individual indicators allows the report user to identify common and different climate and socio-economic vulnerabilities on a district-level. Identifying the root causes of vulnerabilities and key drivers of risk allows for the identification of possible focus areas for the Cotton 2040 programme in terms of supporting climate resilience and adaptation. Lastly, the study demonstrates initial examples of good-practice adaptation cases currently underway in India which help build climate resilience going forward.

It should be appreciated that this study is a first step in assessing community climate risk and vulnerability. It provides results based solely on available datasets. Participatory 'community-based' engagement will be required to fully understand community vulnerabilities and to define appropriate resilience building measures, including where social adaptation-related support and interventions could be best placed. There is a strong body of literature which emphasises this important point.[17]

> Identifying the root causes of vulnerabilities and key drivers of risk allows the Cotton 2040 programme to identify possible focus areas for supporting climate resilience and adaptation.

2.2 | How was the study carried out?

This pilot study essentially carries out two separate analyses, each of which focuses on two separate components of the CVC: cotton cultivation and cotton processing up until the pre-garment manufacturing stage.

The cotton cultivation aspect of the CVC explores at a district-level the risks and vulnerabilities of cotton farmers and their rural communities, and risks and vulnerabilities to the cotton crop itself. The cotton processing aspect of the CVC explores at a district-level the risks and vulnerabilities of manufacturers and the urban/ peri-urban community, and to the cotton processing sectors from ginning to pre-garment manufacturing.

This pilot study focuses on three states, namely, Maharashtra, Gujarat and Telangana, and a total of 13 districts.

2.3 | Core concept of risk: Why is considering socio-economic factors essential in assessing physical climate risk?

Climate change impacts on a given population will be felt differently between individuals due to a range of socio-economic dimensions. The definition of "risk" by the IPCC acknowledges that the concept is the marriage between the physical climate hazards, such as increase in temperature, wildfires or extreme rainfall events, and the vulnerability of the population which will be exposed to the hazard itself.

"Vulnerability" is based on two core concepts; (1) "sensitivity" – the degree to which a population is affected, either adversely or beneficially, by climate variability "sensitivity" e.g. population living in poverty, gender pay gap; and (2) "adaptive capacity" – the degree to which the population has the ability to respond to a hazard, e.g. access to technology, road coverage, literacy rates. The third component of "risk" considers "exposure", i.e. how much of the subject of interest is open to climate impacts, in this case, how much cotton is grown, or how many people are employed as cotton growers.

In line with the definition of "risk" by the IPCC, this CRVA brings together a suite of hazard, sensitivity, exposure and adaptive capacity indicators to form a rich picture of climate risk and vulnerability hotspots, and the drivers behind these hotspots. The CRVA helps to ensure that adaptation options are rooted in strong credible data.

3 RESULTS

The results are comprehensive and complex. Referring to the full results in the report and using the **Climate Risk Explorer tool** and supporting resources is necessary to understand the distribution and composition of risks within and between districts. As such, here, we only cover the high level cross cutting risks.

3.1 | Are there any common issues across all districts?

The Climate Risk and Vulnerability analyses for both cotton cultivating and cotton processing reveal that common indicators exacerbate risk across all districts. As this is a pilot study, this analysis did not cover all districts in each of the three states, however it is possible to make broad approximations based on the general trends revealed in the analysis.

For the **hazard indicators**, these show a clear trend across all districts, in that an increase in temperature, increase in extreme weather events (including heatwaves and extreme precipitation), and increase in climate hazards (flood risk, landslides, wildfires and damaging wind speeds) is projected for the 2040s. All districts are also projected to experience an increase in the number of days at which labour productivity significantly decreases, and, furthermore, all district are projected to experience an increase in the number of days when maximum temperature is projected to exceed the threshold at which cotton can be successfully cultivated (40°C). A study by the International Labour Organisation (ILO) identified that by 2030, the Indian agriculture sector would lose 9% of its working hours to heat stress, a significant increase from 5.8% in 1995. The study also identified that the Indian manufacturing sector would lose 5.3% of its working hours due to heat stress, also a significant increase from 2.9% in 1995. In total, by 2030, India will lose an equivalent to 34 million full-time jobs out of a total of 80 million globally.[18]

As for the **vulnerability indicators**, there are common indicators which are high across all districts, and these include multidimensional poverty, female work participation rates, male and female literacy rates, access to banking services, and access to technology and information. These are key development challenges facing the states which need to be addressed more broadly. While the results are slightly better for urban areas compared to rural areas, the issues identified here are significant for both rural and urban.

3.2 | Are there some key differences between districts?

Some broad state-level differences can be identified. Districts located in the state of Gujarat are at greater risk from **climate hazards** in the 2040s relative to Maharashtra and Telangana. Temperatures across Gujarat are projected to exceed the thermal tolerance limits for cotton more often than in other districts. They are also projected to experience the greatest increase in frequency of heatwaves and wildfires. There is also an indication that the climate will tend towards drier conditions.

The state of Telangana, which is located in southern India, is projected to experience a greater increase in flood risk and precipitation-induced landslide risk relative to other states. In addition, while increased temperature is projected for all districts across the study area, the district located in Telangana are projected to experience the greatest increase in the number of days when temperature exceeds a threshold of 34°C – a temperature threshold at which, according to the ILO, labour productivity is reduced by 50%.[19] This is echoed by the findings of the ILO report, which projects that populated areas in southern India will be one of the regions of the world to suffer greatest from heat stress.

As for the **vulnerability indicators**, some indicators are more pronounced in some states compared to others. For Maharashtra, gender pay gap and absolute wages of cotton growers stand out as key concerns. Telangana has a low percentage of irrigated cotton grown, high percentage of small agricultural holdings, high percentage of rural female head of households, and significantly low male and female literacy rates. For cotton cultivation in Gujarat, key drivers of vulnerability, include high projected water stress, and low organic carbon stocks, however Gujarat especially stands out in terms of significantly low female work participation rates.

To access the full report, the Climate Risk Explorer tool and supporting resources, visit www.acclimatise.uk.com/collaborations/cotton-2040/

4 IMPLICATIONS

4.1 | What does this mean for the cotton industry in India?

In the 2040s, cotton growing regions across India will be subject to **greater heat stress** than under present day conditions. This is of especial concern for cotton growing regions in northern Gujarat which are already growing cotton under temperatures which are close to the upper temperature threshold of 40°C for cotton survival. It may be the case that for some northern regions, a combination of increase in intensity, frequency and duration of heatwaves and high temperature may push cotton beyond its coping limit, significantly reducing the potential cotton growing season in these regions.

A warmer climate also raises health and safety concerns and knock on impacts on labour productivity. Cotton farmers out in the open sunshine will be at most risk, however cotton manufacturers working in poorly ventilated factories in enhanced warmer conditions due to machineries and urban heat island effect, will also be significantly impacted.

In some regions, this increase in temperature is projected to be coupled by an **increase in water stress**. The state of Gujarat is already drought prone and this is projected to be exacerbated, with the potential to exacerbate current water shortages experience across the assessed districts. The cotton processing and textile industry is heavily dependent on water. Urban spaces in India experience high levels of water stress due to various demographic, geographical and climatic reasons. Rural-urban migration to search for employment opportunities, rapid and often unplanned urbanisation, and concentration of production hubs in cities cause significant increases in water demand. Deterioration in water quality, reduction in groundwater levels, inequitable distribution of water resources and an intermittent water supply further impact the availability of, and access to clean water. It is vital that cotton farms and cotton processing factories take action to increase their water security and increase their resilience to future water shortages and drought conditions.

An **increase in extreme weather events** is also projected. Extreme rainfall is projected to intensify across all districts and by up to 5% across the districts in the state of Gujarat, giving rise to climate hazards including flooding and precipitation-induced landslides. Days experiencing damaging wind speeds are projected to increase across all districts, and by up to +10 days in the district of Nandurbar bringing the total number of days to 80 days. All districts are projected to experience an increase in wildfire risk, with the districts located in Gujarat the most at risk with up to 265 days of the year at "high" risk of wildfire.

As for the southern districts which are highly influenced by the monsoon season, damages to cotton processing units following flood events due to poor infrastructure have already been witnessed, with a knock on impact on the textile industry. It is essential that cotton farmers in southern India take measures today to implement flood mitigation measures and improve watershed management more broadly. As for the cotton processing industry, taking action to improve infrastructure and implement contingency plans in the face of flooding or landslide risk is of utmost importance.

> In the 2040s, cotton growing regions across India will be subject to greater heat stress than under present day conditions.

5 NEXT STEPS

5.1 | How should this report by used?

The India Analysis, and the broader Global Analysis, were both generated by Cotton 2040 in response to the lack of comprehensive, readily available information about how the climate crisis is likely to impact cotton production, its supply chain, and the nature of the industry over the coming decades.

The reports and supporting resources are aimed at apparel brands and retailers, cotton producers or those working with them, sustainable cotton standards and industry associations, the climate finance community, civil society organisations working on climate justice and adaptation, and other actors across the cotton value chain.

The information presented in these resources is designed to help users prioritise supporting and implementing adaptation actions to help build climate resilience across the cotton value chain. Users can identify in which districts cotton cultivation or cotton processing aspects of the cotton value chain are at greatest risk from climate change projected for the 2040s. Most importantly, resources allow individuals and organisations to explore the vital drivers which exacerbate risks in these districts, and, utilise this information to address the question:

> **How can I, as a stakeholder in the cotton value chain, take action to help address climate risks and work towards increasing climate resilience in my district?**

Addressing this question forms the core objective of Cotton 2040. Identifying these drivers of risk is a crucial first step in the cotton value chain adaptation story, as it can be used to guide responsible action and drive interventions towards increasing resilience of the CVC to climate change. What is clear, however, is that investing in climate justice and socio-economic resilience IS investing in climate resilience.

The section 'Discussion: Paving the way forward' in the full report makes a first attempt at identifying examples of various programmes, practical activities and research efforts which have been successful in tackling these challenges and building climate resilience of the CVC across India. Each of the components used to calculate climate risks – namely hazard, exposure, sensitivity and adaptive capacity – have been used to structure the discussion. The focus areas are identified i.e., one, some or all districts that will benefit from the proposed adaptation actions. It is also specified whether a solution is applicable for cotton cultivation and the rural communities, or for cotton processing and urban communities. These solutions are intended to demonstrate initial examples of good-practice adaptation cases currently underway in India which help build climate resilience going forward.

The Cotton 2040 Climate Adaptation workstream will further build on this work through 2021-22 and beyond. The focus will be on supporting the sector to further understand the report findings; explore the implications for individual organisations and the cotton value chain; create a more exhaustive pool of adaptation actions and solutions to build resilience; and – critically – identify and act collectively on systemic solutions. We hope you will join us!

To access the full report, the Climate Risk Explorer tool and supporting resources, visit www.acclimatise.uk.com/collaborations/cotton-2040/

To learn more and explore how your organisation can help create a resilient cotton sector, please contact **Hannah Cunneen** at h.cunneen@forumforthefuture.org or **Erin Owain** at erin.owain@willistowerswatson.com.

To find out more about Cotton 2040 visit www.forumforthefuture.org/cotton2040.

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This document is part of a set of resources published by Cotton 2040 aimed at helping actors across the cotton sector to understand the impacts of climate chance on cotton production.

To access the full India-specific analysis, the Global Analysis report, the Climate Risk Explorer tool and supporting resources visit www.acclimatise.uk.com/collaborations/cotton-2040/.

To explore how your organisation can help create a resilient cotton sector, please contact Hannah Cunneen at h.cunneen@forumforthefuture.org or Erin Owain at erin.owain@willistowerswatson.com.

About Cotton 2040

Convened by Forum for the Future with support from Laudes Foundation, Cotton 2040 is a multi-stakeholder initiative to facilitate the shift to a sustainable global cotton industry which is resilient in a changing climate; which uses business models that support sustainable production and livelihoods; and where sustainably produced cotton is the norm. Find out more: https://www.forumforthefuture.org/cotton-2040 or contact Hannah Cunneen at h.cunneen@forumforthefuture.org.

About Forum for the Future

Forum for the Future is a leading international sustainability non-profit with offices in London, New York, Singapore and Mumbai. We specialise in addressing critical global challenges by catalysing change in key systems. For 25 years, we've been working in partnership with business, governments and civil society to accelerate the shift toward a sustainable future. Together we are reinventing the way the world works. Find out more at https://www.forumforthefuture.org or by following Forum4theFuture on Twitter.

About Acclimatise

Since November 2020 Acclimatise is wholly owned by leading global advisory, broking and solutions company Willis Towers Watson. The Acclimatise team is now part of Willis Towers Watson's Climate and Resilience Hub (CRH). The CRH is a market leading centre of climate adaptation expertise, supported by the Willis Research Network, a network of more than 60 organizations in science, academia, think tanks and the private sector working to improve the understanding and quantification of risk, with the aim to improve the resilience of our clients and society as a whole. Learn more at: https://www.willistowerswatson.com/en-GB/Insights/research-programs-and-collaborations/climate-and-resilience-hub.

About Willis Towers Watson

Willis Towers Watson (NASDAQ: WLTW) is a leading global advisory, broking and solutions company that helps clients around the world turn risk into a path for growth. With roots dating to 1828, Willis Towers Watson has 45,000 employees serving more than 140 countries and markets. We design and deliver solutions that manage risk, optimise benefits, cultivate talent, and expand the power of capital to protect and strengthen institutions and individuals. Our unique perspective allows us to see the critical intersections between talent, assets and ideas — the dynamic formula that drives business performance. Together, we unlock potential. Learn more at willistowerswatson.com or contact Erin Owain at erin.wwain@willistowerswatson.com.

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