



Country / City Germany, Hannover
 University / School Leibniz Universität Hannover
 Academic year 2019-2020
 Title of the project MELTING GLACIERS IN THE ANDES- Repercussions on the regional water supply
 Authors Julie Caudron , Jasmin Laske, Carla Santelmann

TECHNICAL DOSSIER

Title of the project	MELTING GLACIERS IN THE ANDES - Repercussions on the regional water supply
Authors	Julie Caudron, Jasmin Laske, Carla Santelmann
Title of the course	Landschaftsarchitektur und Entwerfen - Emerging topics in Landscape Architecture
Academic year	2019 - 2020
Teaching Staff	Prof. Dipl.-Ing. Christian Werthmann, M.Sc. Jonas Schäfer
Department/Section/Program of belonging	Fakultät für Architektur und Landschaft Institut für Landschaftsarchitektur
University/School	Leibniz Universität Hannover



Written statement, short description of the project in English, no more than 250 words

In the drought prone regions of the Andes, glacier melt contributes to a crucial part of freshwater's availability in dry season. Climate change puts these water storage systems at risk. Because of their all-year warm exposition, tropical glaciers are particularly vulnerable to global warming. The accelerated melt rate leads at first to an increased streamflow, which often causes flooding, landslides and erosion. The peak water of many glaciers will soon be reached and the amount of freshwater will begin to decrease.

A 'timeline of retreating glaciers and meltwater' guides the reader through the evolution of water shortage and its repercussions on the life of affected locals and through their eyes. A three-case studies comparison shows how different Andean countries are affected and react towards water scarcity. It is predicted that 97% of the tropical glaciers are doomed to disappear by the end of the century. More than ever, versatile measures need to be taken to ensure continuous and sustainable water supply over time.

Different approaches can be taken to prevent or at least slow down glaciers melting process. Whereas some focus on the glacial retreat's short-term repercussions, others try out innovative ways of water management and search for alternative sources, in order to fight water scarcity even once glaciers will be completely gone. Some promising initiatives have shown that interdisciplinary, multi-purpose and participative projects are key elements in attempting to guarantee Andean water supply for generations to come.

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CLIMATE CHANGE AGAIN

11th International Biennial Landscape Barcelona

Barcelona September 2020
SCHOOL PRIZE

MELTING GLACIERS IN THE ANDES

REPERCUSSIONS ON THE REGIONAL WATER SUPPLY

Julie Caudron | Jasmin Laske | Carla Santelmann

TROPICAL ANDES

WATERSTRESS

- extreme
- high
- medium
- low

GLACIERS

- 100km²
- 10km²

Other:

- droughts
- floods

Excess of water

Enough water

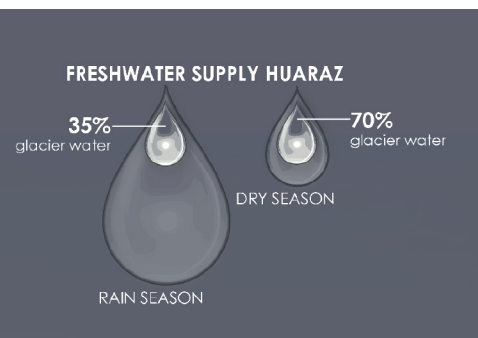
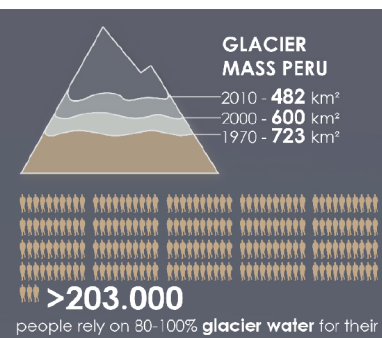
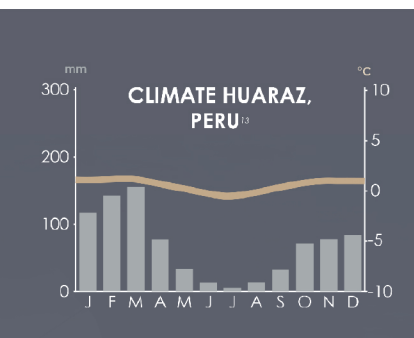
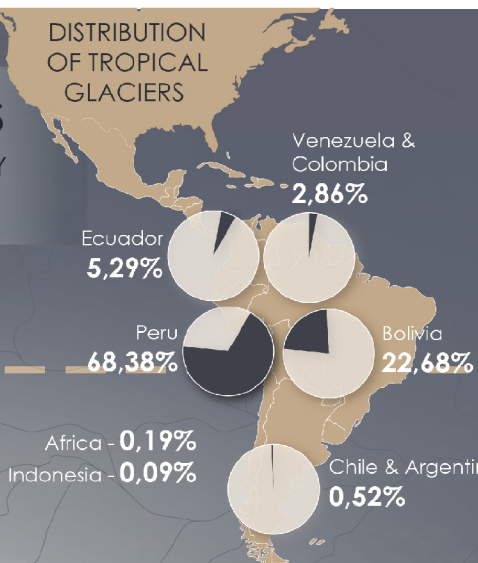
Intensified water shortage 1970

Extreme water scarcity

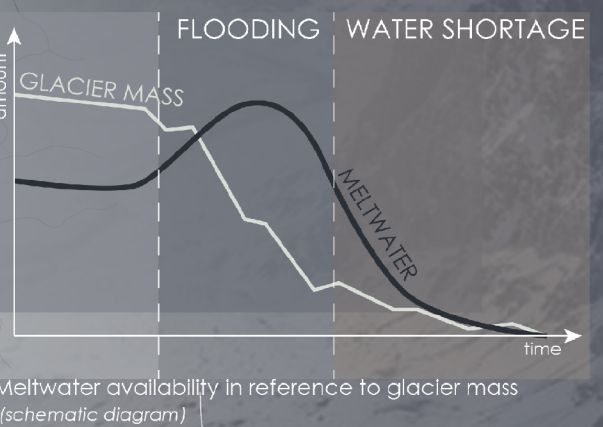
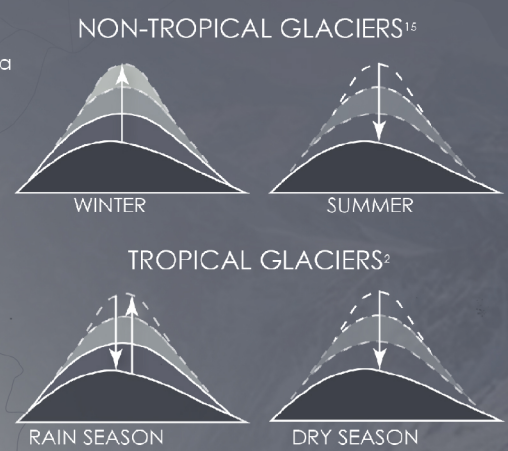
Accelerated glacier retreat⁷

MELT WATER INCREASE

„Temperatures could increase further in the Tropical Andes by between 2°C and 5°C by the end of the 21st century.“



„Glaciers are retreating in every Andean country. The most rapid retreat is in the Tropical Andes, in lower-altitude glaciers.“



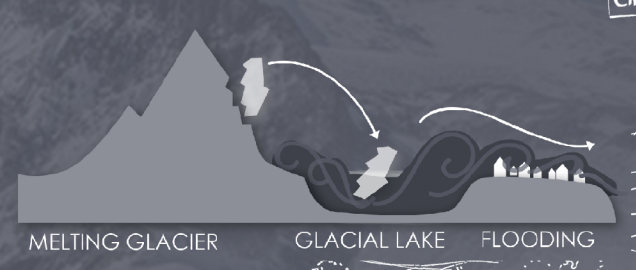
In South America, freshwater is very unevenly distributed. In many areas in the tropical Andes, the glacier melt is a crucial contribution to the freshwater availability in dry season.

With Climate change, the average temperatures rise, the seasonal variability becomes even stronger than it is now and extreme weather events increase. Due to global warming, glaciers are melting, which leads to an increased streamflow at first. The accelerated melt can cause flooding, landslides and/or 'Glacial outburst floods'.

After some time, the tipping point is reached and the streamflow begins to decrease, which leads to freshwater shortage. These affect drinking water resources, agriculture, hydropower, mining and biodiversity. Due to poverty, urbanization, settlements in vulnerable areas and international demands (e.g. for water intensive crops or gold), these problems are further intensified. A lack of basic information and frameworks worsen the situation.

GLOF = GLACIER LAKE OUTBURST FLOOD

A GLOF occurs when a piece of glacier breaks off, falls into the glacial lake, and causes a flood wave.



2000

Government thinks that water scarcity is a lesser problem and focus on flood hazards from glaciers lake outbursts

insufficient adaptation measures

FLOODINGS INTENSIFY

2009

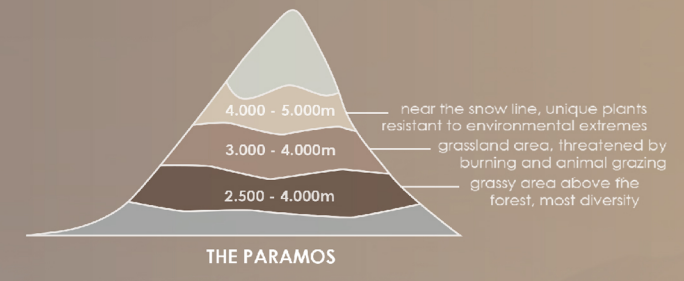
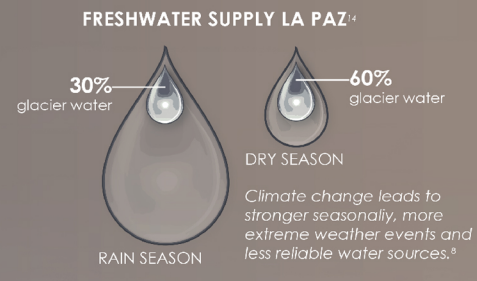
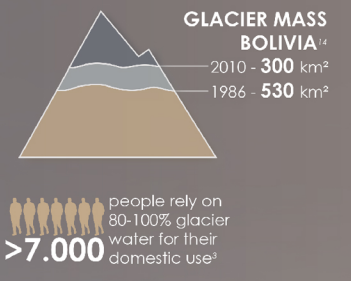
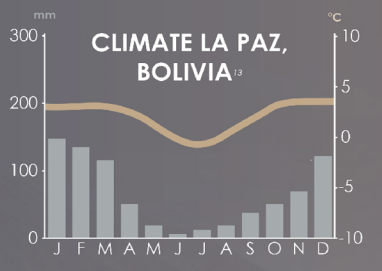
BEGINNING WATER SHORTAGES

37.4% of the Andes' tropical glaciers liquefied between 1980 and 2009.

2014 2015

In Bolivia only 57% of the glaciers left⁴

Mining itself makes up 40% of the economic production in Rio Santa and relies strongly on high amounts of river water to wash and treat the minerals



GROWING MEGA CITIES



MORE THAN 20% OF THE POPULATION IN THE REGION ARE CONCENTRATED IN THE LARGEST CITY IN EACH COUNTRY, HENCE WATER AVAILABILITY FOR HUMAN CONSUMPTION IN THE REGIONS MEGACITIES IS OF GREAT CONCERN.

5% OF PERU'S ENERGY IS PRODUCED IN THE RIO SANTA VALLEY

1.500.000.000\$ LOSS

EVERY YEAR FOR THE ELECTRICITY SECTOR WITHOUT GLACIER WATER



DRINKING WATER

WATER TRUCKS BRINGS WATER JUST EVERY THREE OR FOUR DAYS. FOR RESIDENTS TO FILL JUST TWO CONTAINERS AT A TIME.

Water has to be filtered and treated with bleach before being consumed.

MULTINATIONAL CONGLOMERATES BUYING UP WATER RIGHTS ON EVERY CONTINENT



TOURISM FLYING AWAY

AS WATER SCARCITY DEEPENS IN LATIN AMERICA, POLITICAL INSTABILITY GROWS



"It is said that Ecuador's wealthiest 1% controls 64% of fresh water" she says.
"A single mine can use more water in a day than an entire family in 22 years"

FROM WATER PROTEST TO WATER WAR
= BLUE GOLD

AGING WATER INFRASTRUCTURES

"In many irrigation systems, only 45% of the water reaches its intended destination"

"I think the cars in La paz are partly at fault. But Bolivia is not an industrial country. We are being affected by the rest of the world."

2009 RIP CHAKENTAYA GLACIER

"Nobody listened to us. Every year we could see it getting worse"
"When it does snow up there, the snow is full of grassy black substance"

"This ecosystem isn't just important for plants and animals. The Paramos act like a sponge, collecting water from fog, drizzle and melting from mountaintop glaciers, storing it and then releasing it. An estimated 40.000.000 people depend on the paramo for drinking water" (95% water supply in Quito)

"IF THE GLACIERS MELT ENTIRELY, UP TO 40% OF THE SPECIES LIVING IN STREAMS FORMED BY MELT WATER MAY BECOME EXTINCT"

ECOSYSTEM LOSS

Endangered Species that works as a bio-indicator for water quality in Quito

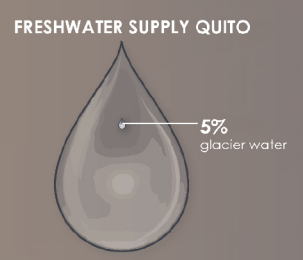
FAUNA And Flora migration

2020
2025

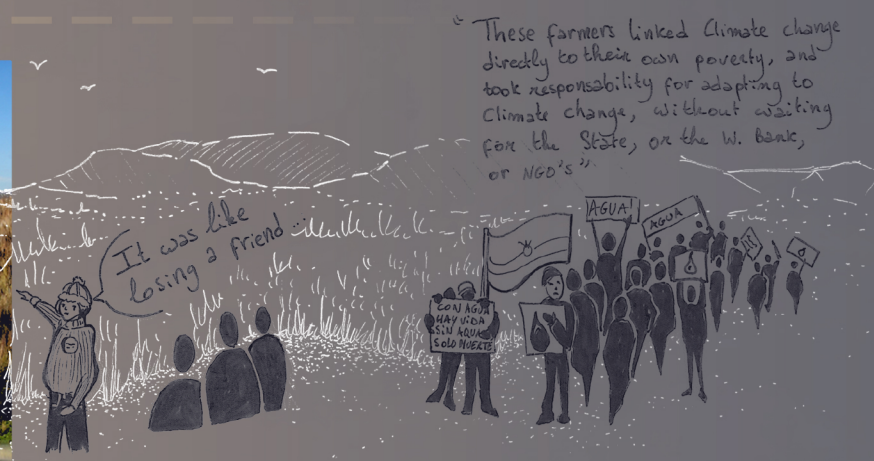
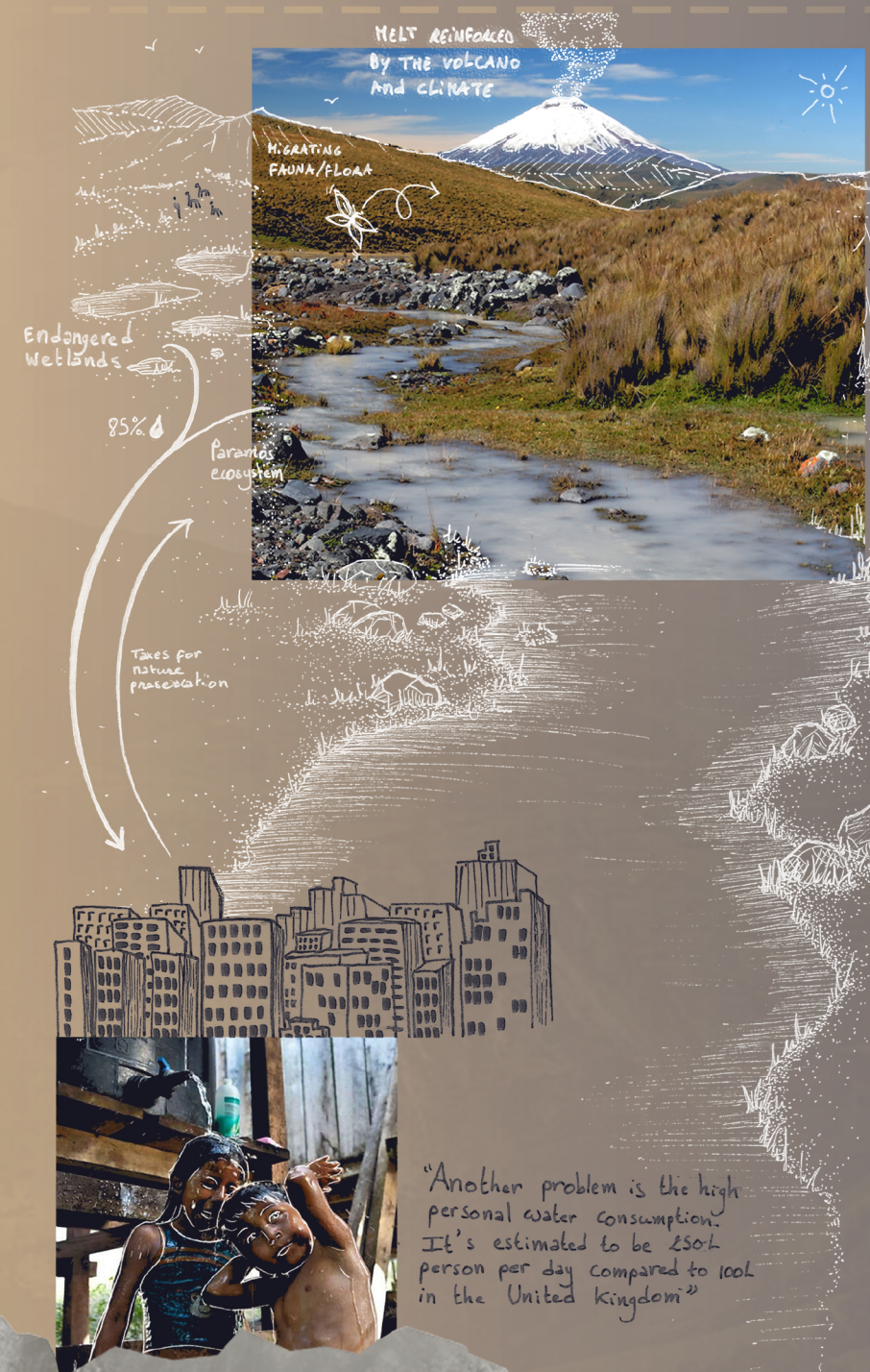
Predicted that all Andean glaciers below 5,000 metres will be gone

2050
Significant meltwater decrease projected (Peru)

HEAVY WATER SHORTAGES



It appears to be a difficult task, **finding improvements for the repercussions of melting glaciers in the Andes.** It may not be possible to present perfectly ready solutions yet, since there is much more research as well as trial and error to be done. Interdisciplinarity, multi-purpose and participative projects are key elements in attempting to find successful improvements for the future, which can not be completely articulated yet.

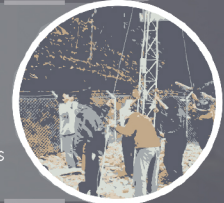


These farmers linked climate change directly to their own poverty, and took responsibility for adapting to climate change, without waiting for the state, or the W. Bank, or NGOs."

IMPROVEMENTS...? SHORT-TERM

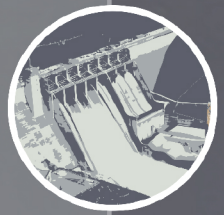
MONITORING AND EVACUATION: GLOF WARNING SYSTEM
Early warning system for Glacier Lake Outburst Floods

- ⊕ Short-term evacuation and safety
- ⊖ No focus on long term-problems



WATER RESERVOIRS AND WATER INFRASTRUCTURE
Improve water collection (dams, reservoirs) and pipe systems

- ⊕ More efficient water collection and distribution
- ⊖ Will not increase the generally available amount of water on long-term, expensive



PAINTING GLACIER AREAS WHITE
White colour to cool down surfaces and accumulate snow

- ⊕ Creates new jobs, easy and effective method
- ⊖ Not yet clear if successful



Short-term improvements focus on possible measures for the still existing glaciers. Early warning systems aim to reduce impacts of the direct floodings, whereas improvement of water infrastructure and the glacier painting attempt to restore or maintain the glacier and its water resources as effectively as possible.

2100

78-97% predicted Andean glacier loss (Peru)

NO MORE GLACIERS?

LONG-TERM

SCIENTIFIC RESEARCH/LECTURE AND PUBLIC EDUCATION
Developing models for future improvements for the water shortage problems

- ⊕ Involving different interests + actors
- ⊖ Very general approaches



RAINWATER COLLECTION
Citizens build their own small-scale water tanks to be more independent from government water supply/ distribution

- ⊕ Effective use of rainwater
- ⊖ May not be sufficient due to increasingly intense droughts because of climate change



AGRICULTURAL IMPROVEMENTS
Three different approaches: Less water intensive crops, ancient terraces system, deficit irrigation



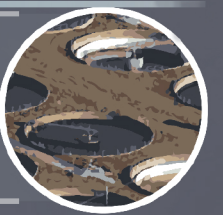
RESPONSIBLE WATER-USE

- ⊕ Always a good approach
- ⊖ Efficient ways may need to be taught, may not be sufficient



WATER TREATMENT AND RE-USE
Well-treated wastewater can be used for agriculture, industry and also drinking water

- ⊕ Sustainable and cost-saving on long-term
- ⊖ Investment in water treatment plants



HEALTHY ECOSYSTEMS
Restoring ecosystems as hydrological storage and natural barriers



Long-term improvements can function beyond the disappearance of glaciers in the Andes. The different strategies are sorted in attempt to evaluate which measures could be most persistent in the decades to come.