Master Thesis
Another Odyssey

Thermic Transhumance

Amélie Bès

Master Thesis

Second Modernity

THERMIC TRANSHUMANCE

Second
Modernity

TRANSHUMANCE

across - land

“a type of pastoralism or nomadism, a seasonal movement of livestock between fixed summer and winter pastures. The traditional farmer or shepherd is seen here to have a generational rootedness and knowledge in the landscape, their hands and herding movements work to gently engineer the earth.”
Armin Linke, Alpi

“Human practice here was based on repetitive time, on a kind of cyclical return of the seasons as rites by which people appropriated their conditions of existence.”
Bernard Crettaz

Armin Linke, Alpi, 2011

Hydrological Drought

Definition

Extreme natural events are no longer a rarity. They have gained increasing attention in the minds of collective conciousness today and will inevitably have an exponentially expanding role in our 2121 day to day realities. This attention comes with concern of the rising frequency and impact of weather-related hazards such as droughts, floods and storms.

Drought is one of the major weather related disasters. Persisting over months or years, it can affect large areas and may have serious environmental, social and economic impacts. These impacts depend on the duration, severity and spatial extent of the hydrological deficit, but also on environmental conditions and the vulnerability of the affected region. Out of all the extreme weather events, drought is "certainly the most complex one"[1]. This exploration and odyssey will concern itself with hydrological drought as:

[a persistent scarcity in rainfall on the capacity and availability of surface water (e.g., rivers, lakes, reservoirs) and groundwater supplies]

Drought, unlike a flood or a storm, does not result in a sudden impact. It is described as a "creeping phenomenon", establishing itself over a longer extent of time and lingering for years. As Wilhite observes, the impacts of this particular hazard are less obvious and spread over larger areas than damages resulting from other natural hazards.[2]

Among the immediate effects of drought there is a significant decline in agricultural production, an increased risk of forest fires and the problem of quantitative and qualitative water-supply. Long-term effects provoke land degradation and desertification which often occur in the aftermath of repeated drought events.

Olafur Eliasson, The Weather Project, 2003

Drought is a severe natural hazard that affects more people than any other natural disaster. More obviously so when social, economic, or environmental impacts become apparent. Drought is different from other natural hazards as per the difficulty to easily identify its apparition and termination. Also unusual is the fact that it is a hazard of scarcity rather than one of excess.

Complex phenomenons with a multitude of facets and involving numerous interacting climate processes, drought does not apply to a conventional dichotomy between ‘natural’ and ‘social.’ Bruno Latour, notes: “The challenge of analysis of environmental phenomena such as drought arises from their simultaneously multidimensional character - at once “real, like nature, narrated, like discourse, and collective, like society.”[3] This is due to the hybridity of it‘s character and the human role in it‘s onset.

This complex hydrometeorological event is caused by meteorological anomalies but is also affected by the state of the various elements of the hydrologic balance. The balance of the hydrosphere is influenced by the precipitation deficit that is itself altered by the following factors: surface runoff, soil moisture, streamflow and groundwater flow.[4] Mitigating drought impact is thus one of the major water management challenges in certain regions of Europe and the hydrosphere.

Three types of droughts are generally distinguished: meteorological, hydrological and agricultural. Meteorological drought refers to a period of below-average precipitation. It is often accompanied by above-normal temperatures. Hydrological drought is characterised by below-average water levels. Finally, agricultural drought is a period of dry soil, resulting from lower than average rainfall and higher than average evaporation.[5]

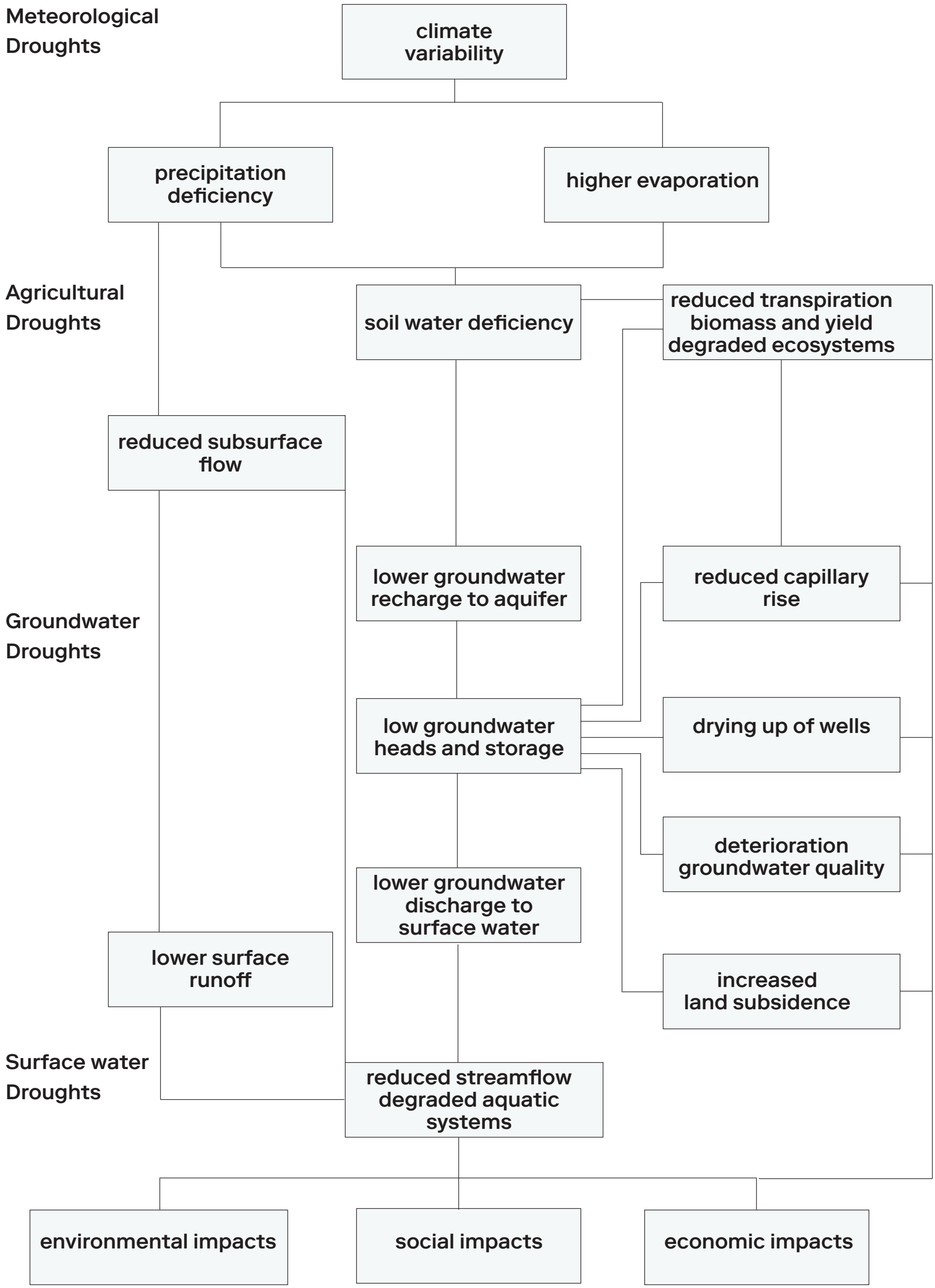


 Fig. 1: Schematic outline of different droughts[1]

The following drought index uses the formulation of Thornthwaite (1948), which requires monthly mean temperatures and precipitation sums:

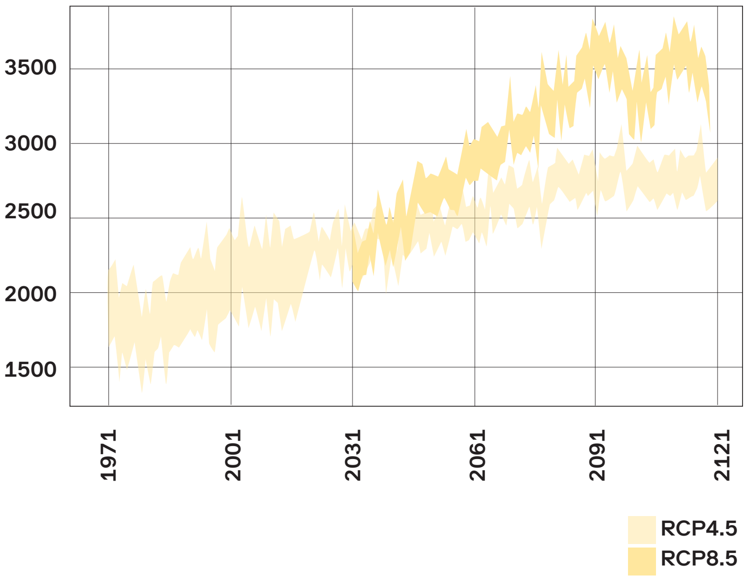
DRI = P - ETp

P is the precipitation sum of August, of the previous year, to July, of the current year.

ETp equals to the sum of estimated potential evapotranspiration of August, of the previous year, to July, of the current year, as a function of monthly mean temperatures and geographical latitude.

DRI being the drought index and values below zerow indicating moisture deficits.[6]

Fig. 2: Day Degree Sum [°C], Valais



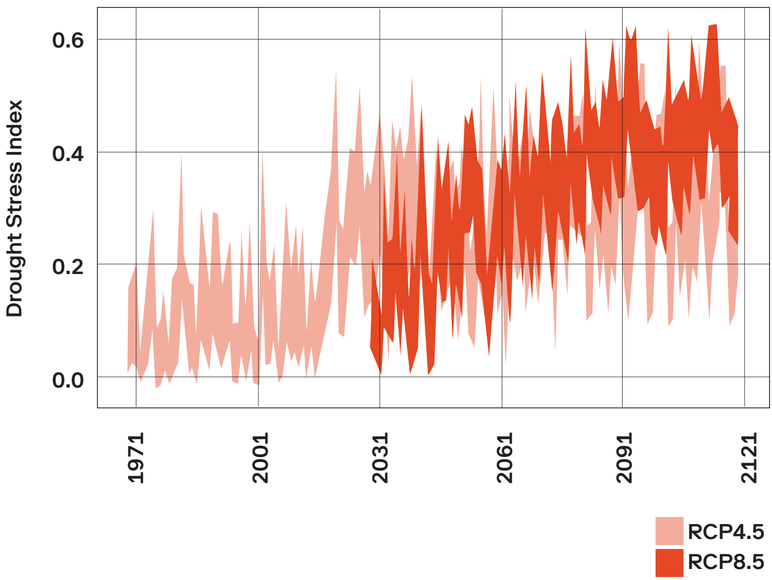
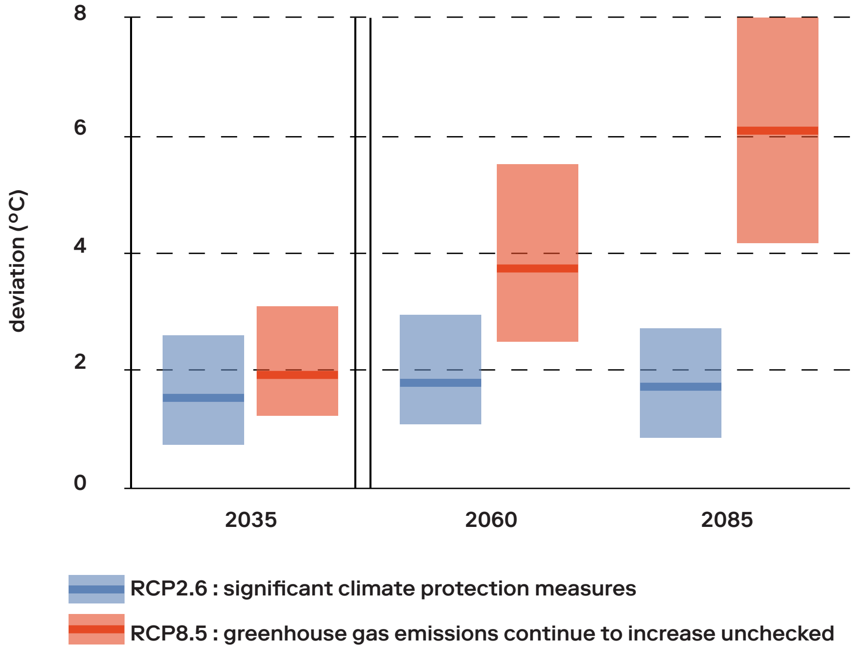


Fig. 3: Drought Stress Index, Valais

According to climate forecasts, which predict a rise in temperatures and a decrease in precipitation, an increase in drought in Switzerland is to be expected. Today, in Switzerland, we can already observe a trend, that will continue increasing, of tropical nights. “Summer heat waves, closely linked to drought, are expected to occur much more often by the end of the century than they have to date.”[7] Prof. Dr. Christoph Schär, a climatologist at the ETHZ, stated the following; “The 2018 heatwave was a warning for the future. The extremes we are seeing at the present time could become the norm by 2060.”

The Alpine region in the past 30 years, has witnessed a temperature increase almost twice as high as the global mean. Strong rainfall is foreseen to be more intense, but snow days and glaciers are dwindling and winters will be milder. This fast-changing transformation will only accelerate after the second half of the 21st century relatively to how we act and adapt in the near future. Climate models suggest that towards the end of the century not only will the frequency and intensity of drought periods in Switzerland be greater, they will persist for longer periods of time.[8]

Fig. 4: Deviation of standard temperature of 1981-2010 for summer in the Canton of Valais untill 2085



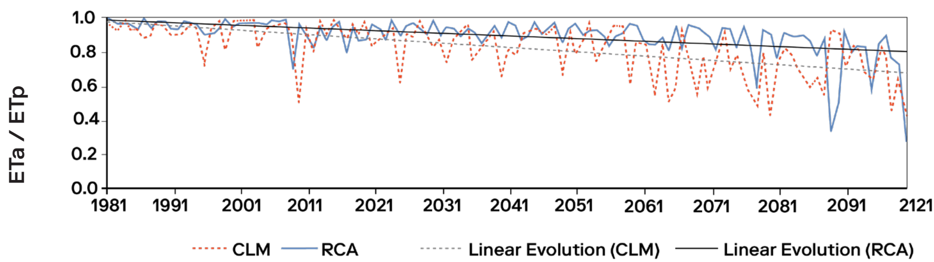


Fig. 5: Evolution of the ETa/ETp ratio in Switzerland

The Valais is composed of an array of different climatic zones. Whilst the Upper Valais and the Simplon region have a humid mountain climate with high annual precipitation and relatively low average temperatures, the area between Brig and Martigny is semi-continental, with Mediterranean influences.

The Rhone valley and the side valleys of the Canton of Valais have steep slopes and strong climatic gradients. While certain native vegetation is adapted to low water conditions, water availability critically influences ecosystems and the provisioning of these. The territory of the Upper Rhone Valley is considered one of the driest of the inner-alpine valleys with less than 600mm of rainfall per year between Visp and Sion.[9]

As per the synthesis report of the Canton of Valais on natural hazards, the canton is expected to be subject to a warming that is above the Swiss average. It will be much greater than the current natural variability. In 40 years' time, a normal summer could like that the scorching hot one of 2003. [10]

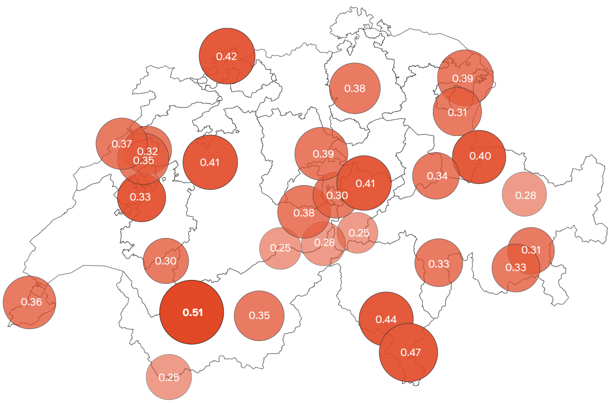
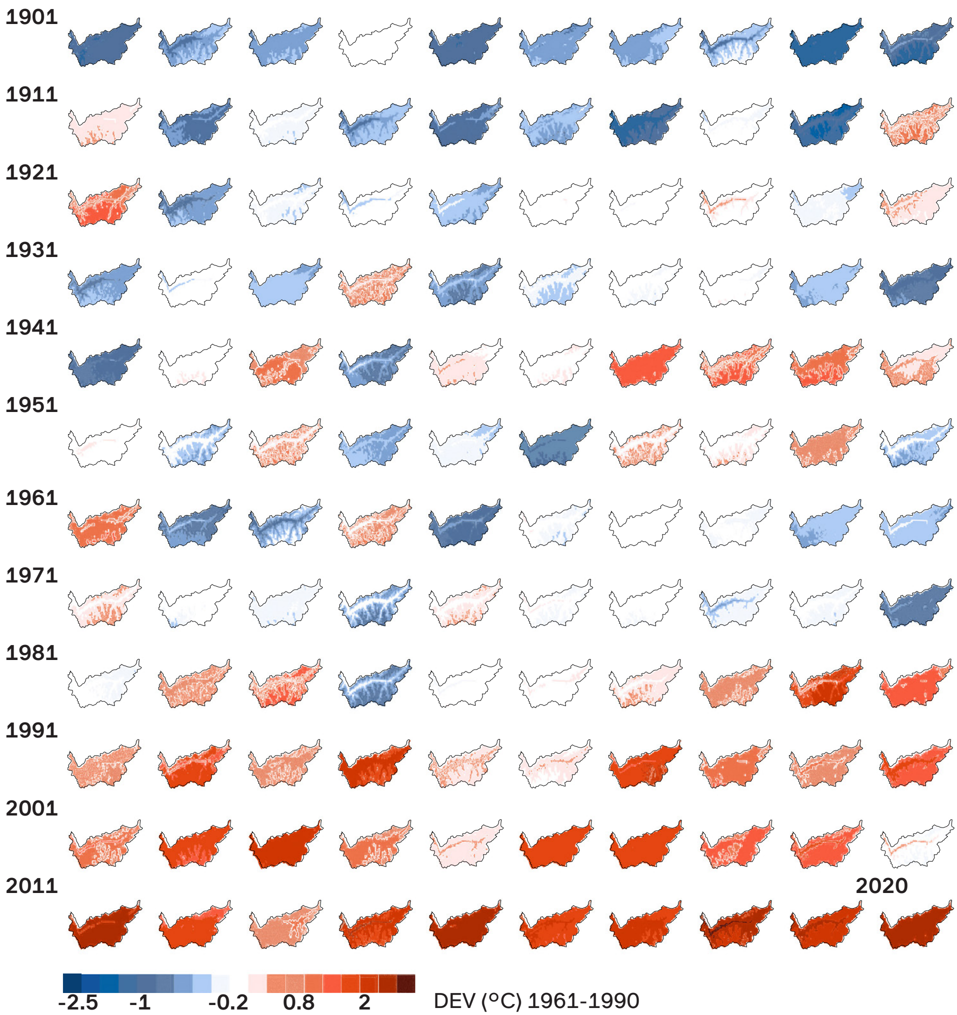


Fig. 6: Annual temperature trends [°C/decade] 1984-2013

Fig. 7: Temperature increase from 1901 untill 2020 in the Canton of Valais



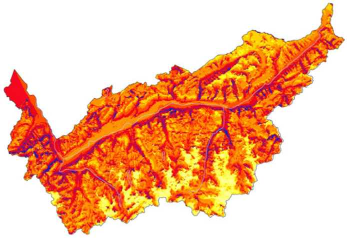
From 1865 until today, heatwaves have become 200% more frequent and intense. Furthermore, the local hot and dry climate is affected by the warm local foehn that increases evapotranspiration. Warmer regions are caused by the ratio of evaporation and humidity, which is relative to the temperature.

Due to the rising demographics, the increase of tropical nights and water demands, seasonal and local, will be a significant problematic in 2121. The value of the resource of water and the illusion of it‘s endless availability will thus become more and more present and the demand for water will come into conflict with it’s availability. In the Central Plateau in particular, this increased demand will be consequence of intensive agricultural irrigation and expected population growth.

All the cultures, or almost all the villages, are systematically located on the slope facing the south-east and the sun exposed side, this is the “essential fact which strikes the most indifferent traveller”.[11] Adret and ubac are the name designating the slopes facing the southern and the northern sides. The etymology of adret comes from the Old Occitant meaning “to, towards”. Perhaps even more expressive are the terms „endroit“ and „envers“; on the one hand it is the natural place of the village and the crops, on the other a preferred site for human settlements.[12]

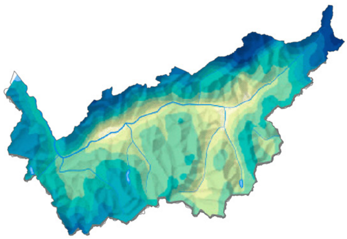
Fig. 8: Evolution from 1981 to today

temperature
+2.2°C

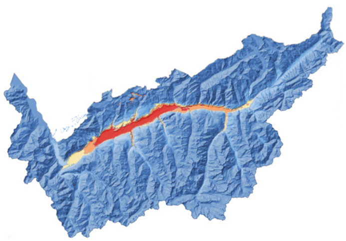


water in soil
-20mm
(-5%)

rainfall
-66 mm
(-11%)



evaporation
+60mm
(+11%)

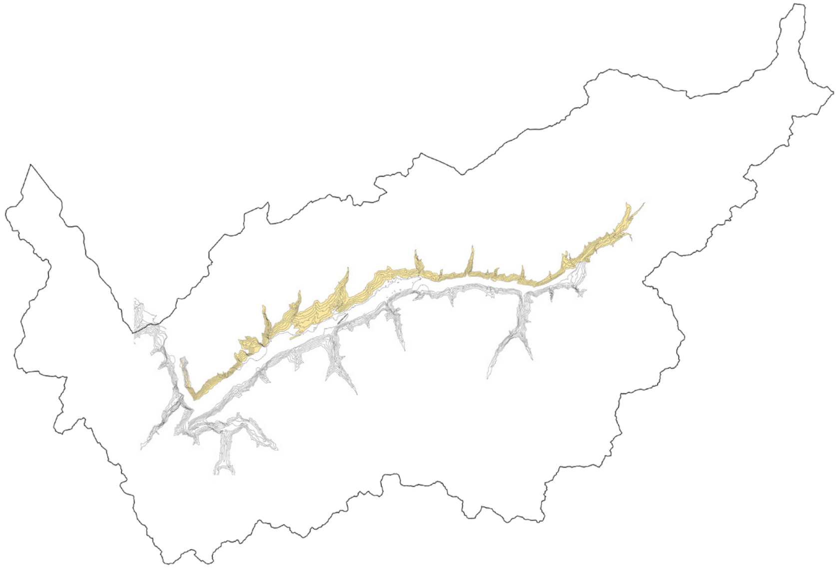


	SUN	SHADE
German	*Sonnenseite* *Sonnenberg*	*Schattenseite* *Schattenberg*
French	*Adret* *Endroit*	*Ubac* *Envers*
Italian	*Indretto* *Adritto*	*Inverso* *Opaco*

Endnotes

1 Vogt, Jürgen V. and Somma, Francesca (2000) Drought and Drought Mitigation in Europe
2 Wilhite, D. A. (1993) Drought Assessment, Management and Planning: Theory and Case Studies, Kluwer Academic Publishers
3 Latour, Bruno (1993) We Have Never Been Modern, Harvester Wheatsheaf, London
4 Vogt, Jürgen V. and Somma, Francesca (2000) Drought and Drought Mitigation in Europe
5 Wilhite, D. A. and Glantz, M. (1985) Understanding the Drought Phenomenon: The Role of Definitions
6 Bigler, Bräker, Bugmann, Dobbertin & Riggling (2006) Drought as an Inciting Mortality Factor in Scots Pine Stands of the Valais, Switzerland
7 https://www.dora.lib4ri.ch/wsl/islandora/object/wsl%3A13288/datastream/PDF/view
8 https://www.wsl.ch/en/natural-hazards/weather-and-climate-extremes-and-drought.html
9 Kienast F. 1985a. Dendroökologische Untersuchungen an Höhenprofilen aus verschiedenen Klimabereichen. Inaugural-Dissertation. Zürich: University of Zürich
10 Le Valais face aux changements climatiques, Documents de Synthèse, VS
11 Vessereau, Marcelle (1921) L'Adret et L'Ubac dans les Alpes Occidentales
12 Vessereau, Marcelle (1921) L'Adret et L'Ubac dans les Alpes Occidentales

Fig. 9: Adret, Canton du Valais



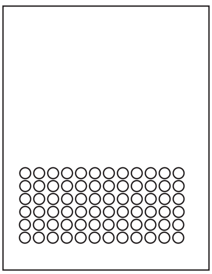
Hydrosphere

Solid Liquid Gas

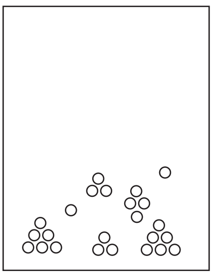
Water is found in all three forms in the earth‘s atmosphere. It is a constantly circulating element, constantly in movement and constantly experiencing changes of states. The importance of these changes makes water the main agent for the transport of physical, chemical and biological elements. All these processes of transformation form the ensemble of the hydrological cycle, the hydrosphere.

Climate change inevitably alters the composition of this hydrosphere in the states of ice, water or water vapour. This affects the entirety of the hydrological cycle. Observing this cycle, it is observed that both floods and drought are two extremes it. Looking at the hydrosphere, the words of Robert Smithson resonate „Nature does not proceed in a straight line.“ This idea of how things move forward, give a direction to time, also link with the concept of entropy as the gradual movement of the system as a movement from order to disorder. It evokes the irreversability of a condition, of our human condition and of the elemental condition of things.

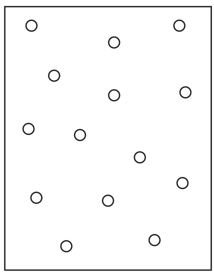
The idea of water being an “arche”; a principal, an element, before any theory of evolution suggests that everything comes from water. “If you stretch water, you get steam and gas; if you compress water, you get earth and firm things.”[1]



solid



liquid



gas

Gehrard Richter, Wolken, 1969

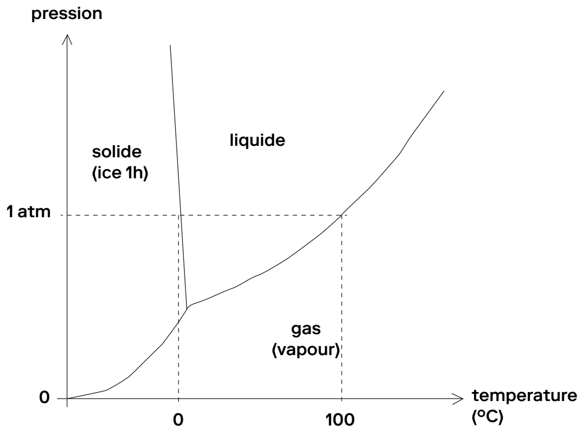
All over the world over 80% of the energy supplied by the Sun is used in the evaporation of water. This process prevents the surface of the Earth from overheating. This evaporation is usually not measured directly but is derived from the hydrological balance. Evaporation is defined as the transfer of water from a liquid to a gaseous state, taking place in water surfaces, in soil and in vegetation. Water vapour is taken up by the air as an invisible gas.

When it comes to rainfall, there is a somewhat wide knowledge of it‘s geographical variations and of how it varies yearly. “On the other hand, no instrument has yet been perfected to measure the water movement from the earth to the atmosphere, and consequently we know next to nothing about the distribution of evapotranspiration in space or time.”[2] Whether a climate is moist or dry, depends on more factors that rainfall alone. Both precipitation and evapotranspiration are equally important climatic factors of the hydrosphere. This evapotranspiration is influenced by a variety of atmospheric factors including sun exposure, air temperature, wind intensity and atmospheric humidity.

Evapotranspiration is the reverse of precipitation and is a key variable of the landscape‘s water balance. “It describes the exchange of water between the land surface including plants and the atmosphere and is, therefore, a measure of water loss.”[3] Evapotranspiration is here defined as:

[The flux of water that is returned to the atmosphere from the surface of the earth to the atmosphere by evaporation, sublimation and transpiration.]

Fig. 1: Phase diagram for water



Olafur Eliasson, Fog Assembly, 2016

In the region of the canton of Valais, the evapotranspiration process is accelerated by the Alpine warm Foehn blowing across the valley. On the long term, this will endanger the supply of water to the lower-lying regions in and around the Alps. Several factors due to global warming play into this scenario: the general reduction in precipitation, the dwindling of glaciers and, in dry and warm summer months, evapotranspiration will intensify the problem of lower runoff volumes.

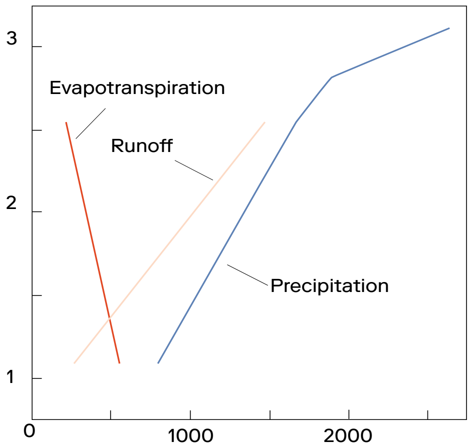
The lack of water available for the trees and plants to absorb has the consequence of the vegetation and soil having less capacity to release water into the atmosphere. As a result of this, the balance dries up and further warms the air which therefore will gradually deteriorate and alter the hydrosphere.

Actual-Potential

"The vegetation of the desert is sparse and uses little water because water is deficient. If more water were available, the vegetation would be less sparse and would use more water. There is a distinction, then, between the amount of water that actually transpires and evaporates and that which would transpire and evaporate if it were available. When water supply increases, as in a desert irrigation project, evapotranspiration rises to a maximum that depends only on the climate. This we may call "potential evapotranspiration," as distinct from actual evapotranspiration."“[4]

The relationship between actual evapotranspiration ETa and potential evapotranspiration ETp is a measure of water availability and reflects drought impact on vegetation. The actual evapotranspiration ETa depends on the availability of water, on the amount of precipitation and the capacity of the soil to store rainwater. The potential evapotranspiration ETp is the amount of water that would be released into the atmosphere if sufficient water were available.

Fig. 2: Elevational variation of yearly rainfall, evapotranspiration and all drainage processes



Ed Ruscha, Desert Gravure, 2006

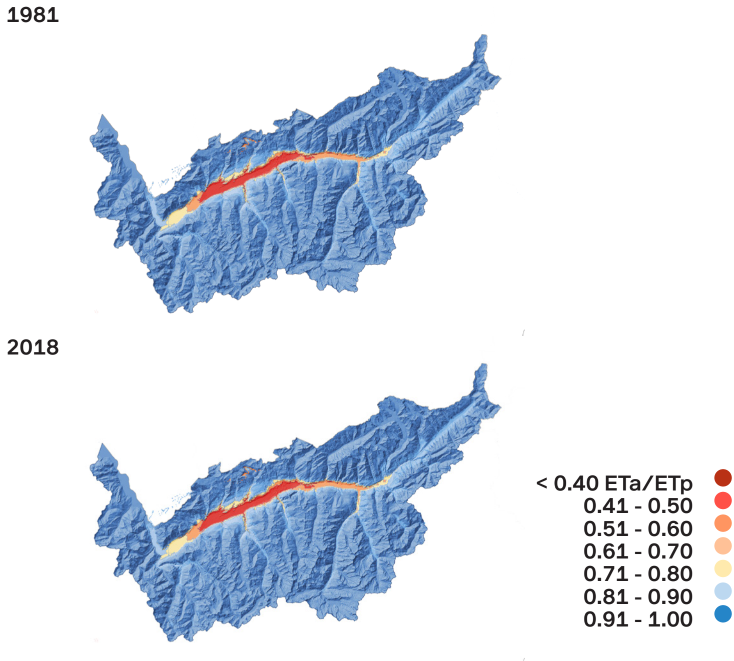
Evapotranspiration is the sum of evaporation, direct water evaporation from open water surfaces and soil, and transpiring vegetation. The ETa/ETp ratio does not only take into account soil water in the calculation, but also temperature and radiation. This ratio is an indicator of whether the trees can actually draw water from the soil to transpire. If this ratio falls under a certain figure, the vegetation will save water by closing the stomata of it's leaves. In this case, the plants are no longer able to photosynthesise. The following equation is the critical limit of the ratio, under which drought disturbances can be expected.[5]

$$ETa / ETp < 0.8$$

Linking atmosphere and water, the surface of the earth is of central importance in the hydrological system. Persistent sun exposure and warmer meteorological conditions will influence this hydrosphere by boosting evapotranspiration.

In the future, the Valais, which is already known for it's droughts, is not likely to be the only one affected by water shortages.[6] The radical increase of the day degree sum in the Canton of Valais untill 2121 will have a direct influence on evapotranspiration. Increased evapotranspiration will have consequences on water supply and demand, leading to critical soil moisture values and the associated agricultural drought. Whereas actual evapotranspiration will be determined by the local availability of water. "By the end of the century, scientific research expects the average evapotranspiration in Switzerland to increase by 5% with climate protection measures and by 10% without climate protection measures."[7]

Fig. 3: Ratio ETa/ETp in the Canton of Valais



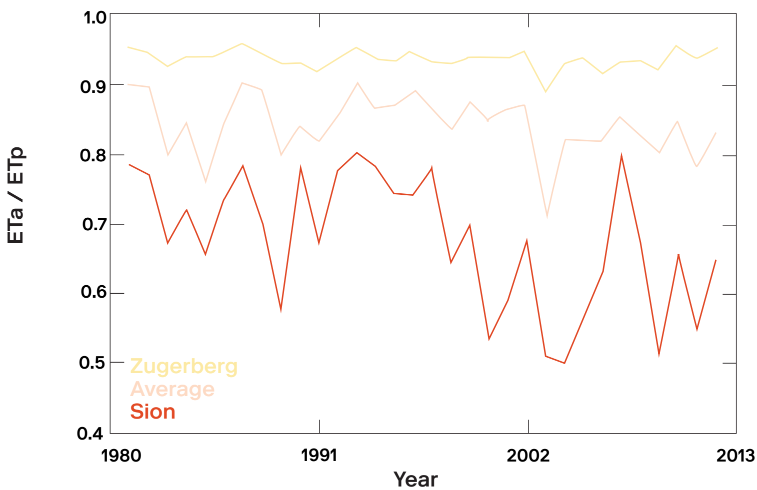


Fig. 4: Trends of ETa/ETp in Switzerland, 1981-2012

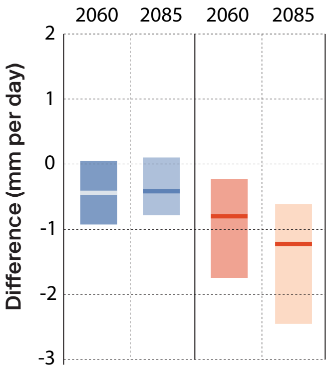
The graph (Fig. 5) shows the evolution of the precipitation and evapotranspiration balance. By the end of the century, without climatic protection measures, most regions can expect to lose an average of 1 millimetre or more of water per day in the soil and in flows during the summer. “This corresponds to about 20 % of the current average summer precipitation in Switzerland. During extra-ordinary periods of drought with a sustained deficit in precipitation, the decline in water availability can be even greater.”[8]

Re-Source

The rapidly changing hydrological landscape of Switzerland due to climate change will induce seasonal flow redistribution and therefore have consequences on water management. Considering that by 2121, the Alps and their towering white mountains will have lost more than nine-tenths of all of glaciar ice, the swiss hydrosphere will undergo massive morphosis. Mentalities will undoubtedly have to adapt to this dissapearing symbol of what has been romanticized for centuries. Hydrological supply for certain locations will definitely be lacking seasonally and “future increase in the demand for water will be most critical in periods of severe low flow and extensive droughts.”[9]

The flows and storage capacity of the hydrosphere will be influenced by the change of state of the ice and snow melting. The snow-covered areas will reduce and winter‘s meltwater reserves will continue diminishing. Altitudinally, this will have the impact that “for every degree of temperature increase, the rain-snow line rises by 150 metres.”[10] In Switzerland, a low-water situation also occurs in winter when precipitation, stored in the form of snow, does not replenish the hydrological cycle, and in dry weather when there is no precipitation at all.

Fig. 5: Seasonal modification of the indicator "Precipitation minus evapotranspiration" (d[P-E]),



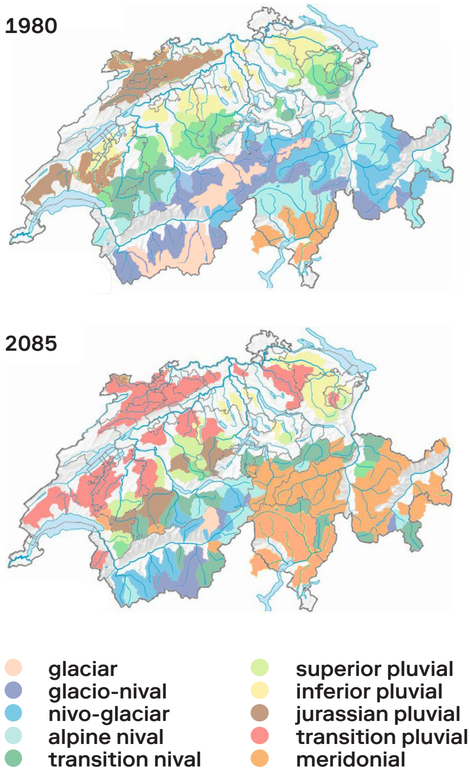


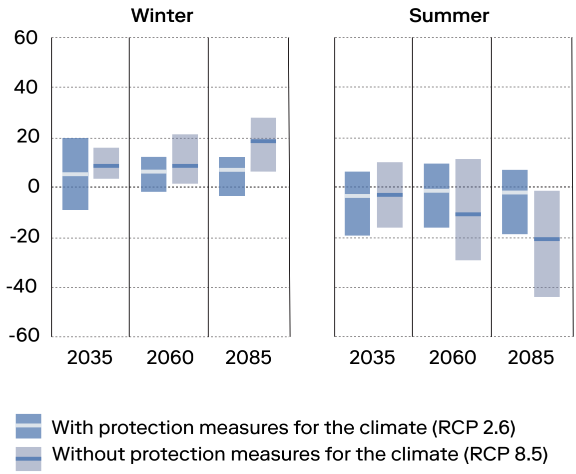
 Fig. 6: Flow regime changes, CH Hydrological Atlas

Water management will thus have to be geared towards warmer and drier summers and aligned to the dissapearing melting natural reservoirs. The Swiss government is working on warning and monitoring systems for drought, similar to those already in place for forest fires or floods. “The aim will be to ensure that sufficient water is available for both the local population and agriculture despite the lack of rain, and that the level of the groundwater does not fall too much.”[11]

Both in terms of absolute precipitation and the number of days without rain, the canton of Valais is the driest in Switzerland.[12] It is expected that in Switzerland, summer rainfall may decrease by up to 28% but even without this significant decline in precipitation, “the risk of drought could be more pronounced due to higher temperatures leading to more evaporation.”[13]

The water resources available include surfaces of stagnant water and that of rivers. The flows of rivers are a function of the regional water balance, which takes into account precipitation, evaporation and the variation of water reserves. As for groundwater, it naturally acts as a buffer to both floods and droughts. For example, floods can recharge groundwater levels, which can mitigate droughts. In arid and semi-arid areas, groundwater is often the most reliable source of water.[14]

Fig. 7: Future summer and winter average precipitation difference in Switzerland compared to 1981-2010



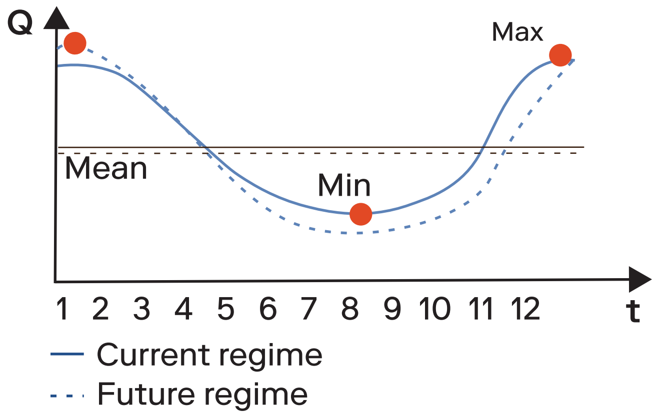


Fig. 8: Dominated flow regime under current and future conditions in Switzerland

Endnotes

1 Hampe, Michael, Panta Rhei and Platos Revenge in The Four Elements and Architecture : Earth Water Air Fire, edited by Mateo, José Lluis and Sauter, Florian, pp. 182, Barcelona: Actar Publisher, 2014.

2 JOURNAL ARTICLE: An Approach toward a Rational Classification of Climate, C. W. Thornthwaite (https://www.jstor.org/stable/210739?seq=48)

3 Crocetti, L., Forkel, M., Fischer, M. et al. Earth Observation for agricultural drought: current state and future directions. Reg Environ Change 20, 123 (2020). https://doi.org/10.1007/s10113-020-01710-w

4 JOURNAL ARTICLE: An Approach toward a Rational Classification of Climate, C. W. Thornthwaite

5 Allgaier Leuch B., Streit K. and Brang P. (2017) La forêt suisse face aux changements climatiques: quelles évolutions attendre?
https://www.dora.lib4ri.ch/wsl/islandora/object/wsl%3A13288/datastream/PDF/view

6 Allgaier Leuch B., Streit K. and Brang P. (2017) La forêt suisse face aux changements climatiques: quelles évolutions attendre?

7 https://www.nccs.admin.ch/nccs/fr/home/secteurs/gestion-des-eaux/impacts-des-changements-climatiques-sur-le-bilan-hydrique/humidite-du-sol-et-evapotranspiration.html

8 https://www.nccs.admin.ch/nccs/fr/home/secteurs/gestion-des-eaux/impacts-des-changements-climatiques-sur-le-bilan-hydrique/humidite-du-sol-et-evapotranspiration.html

9 Jürgen V. Vogt and Francesca Somma, Drought and Drought Mitigation in Europe

10 http://www.occc.ch/pdf/855.pdf

11 Diagonal WSL Magazine, N° 2, 2020

12 L‘irrigation par les bisses en Valais Approche géographique, Emmanuel REYNARD

13 Synthesis Report, Le Valais face aux changements climatiques, Canton of Valais

14 https://www.sciencedirect.com/science/article/pii/S2468312420300109

Francis Älys, Paradox of Praxis, 1997

Ager-Hortus

The character and tradition of the Canton of Valais has a strong connection with it‘s topography and agriculture. This land has witnessed resilience and hard work, requiring collective effort as a strategy. Peter Kropotkin interested himself with the subject of the tradition of co-operation and mutual aid that has shaped the cultural landscape of Switzerland and persisted through time.[1]

The reality and challenge is that the Valais, considering it‘s rising demographics, must foresee it‘s agricultural productivity and supply management. Additionally, it will “suffer from a dramatic loss of income due to drought in some years.”[2] To these problems, are overlayed the critical needs for densification of housing but there is also the problem of loss of agricultural land. This duality looks for the potentialities in bringing these demands together and forward. These problematics also will come into conflict with one another, in the fact that both sectors will need an increasing supply of resources. The domestic sphere and agricultural sector will inevitably come into conflict with tropical nights and freezing days.

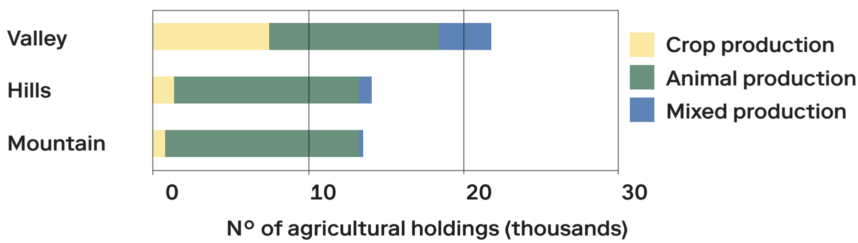


Fig. 1: Agricultural holding according to location, 2020

Athanasius Kircher, The Terrestrial Paradise, 1675

The romans distinguished the *urbana*, the *rustica* and the *fructuaria*. Additionally, the field *Ager* was distinguished from the garden *Hortus* which took the form of an enclosure. The hortus conclusus refers to a symbol of paradise, to the idea of Eden and the embodiment of ideals. Both agriculture and horticulture, refer, in the latter part of the word, to the action of cultivating.

agriculture
[ager] field [cultura] cultivate
horticulture
[hortus] garden [cultura] cultivate

The local urgency being one of the densification of dwelling and of the loss of agricultural land, the dualism here brings agriculture closer to the garden and closer to the domestic realm. Agriculture being a vast field, the one deriving directly from the root of *hortus* is the more specific interest of this research. Horticulture is a branch of agriculture including the cultivation of vegetables, flowers, trees and fruit trees. The following prayer alludes to the garden, it‘s benefits and fruits:

“Grant that I may enter and leave my garden,
that I may cool myself in its shade, (...)
that my soul lay itself down of the trees I planted,
that I may refresh myself under my mulberry trees.”

Looking towards living and cultivating in 2121, alternatives are searched for and Sébastien Marot speaks of a resilient horto-agriculture “aiming at a certain self-sufficiency and likely to be developed in sites of all sizes and natures.”[3] This approach is one of permaculture which engages with changing principles and tracks. David Holmgren voices how we must accept our role in using our “habit of permanent change to adapt to the descent in energy.”[4]

Andrea Branzi, Agronica, 1995

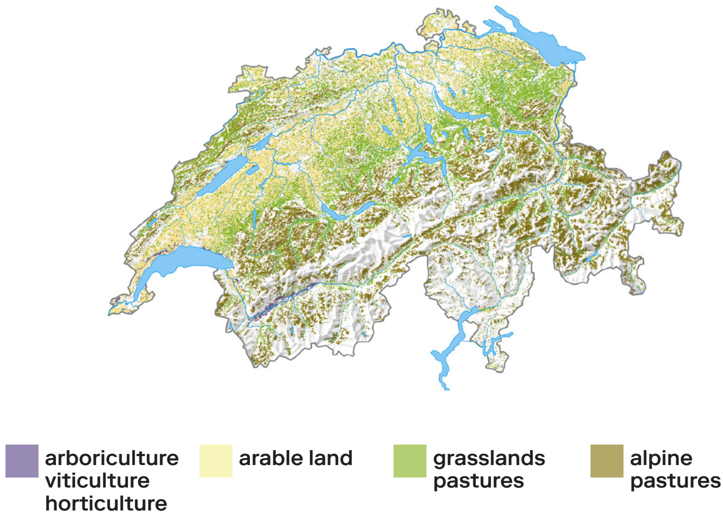
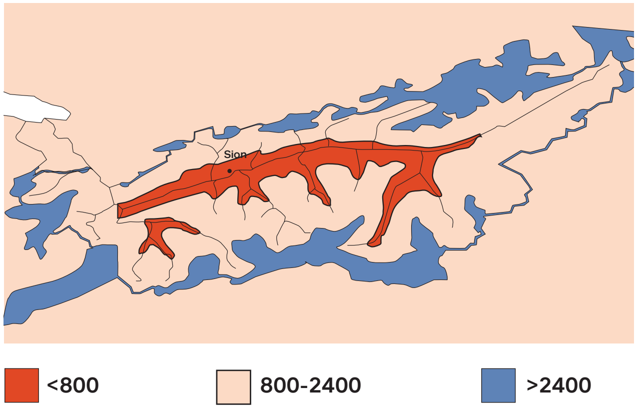


Fig. 2: Agricultural use of soil in Switzerland, which covers 36% of Swiss Land surface

Migrating altitudinal zones, rising temperatures and shifting seasons will alter the face of the Valais of 2121. With this shift comes a shift in growing seasons witnessing productivity potentials but also freezing flowers. As per Pierluigi Calanca, there will be higher potential for growing seasons and we could imagine three blossoming periods. The growing period in summer will have to face very difficult conditions, depending on which climatic prognosis we are looking at. Speculating about the RCP 8.5 scenario in 2121 shows us that we would see a rise of 6°C which makes survival through varietal adaptation impossible and entails a lowered productivity. In Switzerland, we can expect approximately 1-2 months extension of the growing season untill 2121.

Hydrological drought and high exposure to frost is accompanied and explained by increasing variability and unpredictable weather. As Annelie Holzkämper states, “the increase in variability will be the greater challenge to agriculture than warming.” To counter this seasonal and climatic unpredictability, the agricultural sector will have to resort to diversification.

Fig. 3: Yearly precipitations (mm)



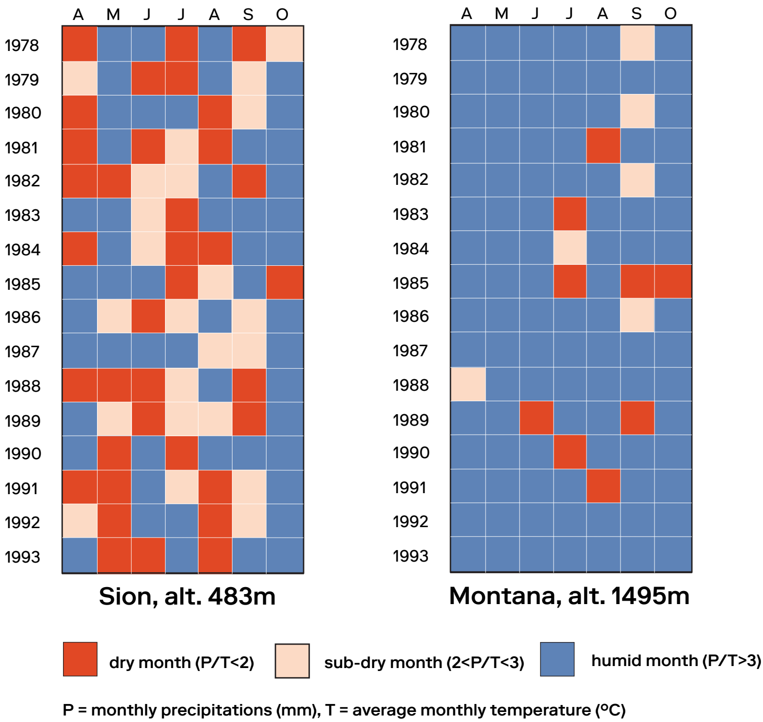


Fig. 4: Ecologically dry months during the growing season in Sion and Montana

Agriculture and horticulture are directly exposed to progressive warming, changes in the hydrosphere and soil characteristics as well as to the potential greater frequency and intensity of extreme events. The future of these sectors see more potential but also more risk. Increasing frequencies of heat and drought extremes are expected to have detrimental effects on productivity. However, warmer temperatures also lead to possibilities potentially being a benefit to agricultural productivity.[5]

This longer growing cycle by definition will need more water. This will come into conflict with the increasing temperatures and decreasing precipitation trends in summer months. "Even though we have comparatively abundant water in Switzerland, in the long term there could be conflicts of interest between farms and drinking water distributors," says Holzkämper.

An average temperature rise of 2 to 3 °C may make agriculture more productive, provided sufficient nutrients and water are available. The longer growing season will increase the potential of grassland and crop production as well as the possibility of growing several crops per year. Higher temperatures are also an opportunity as this creates the possibility of cultivating new crops. The longer growing season has the potential of productivity but also "entails a risk: a longer growing season also means that something can go wrong for longer, especially in the case of drought and heat stress."[6]

Mario Giacomelli, Metamorphosis of the Earth, 1960

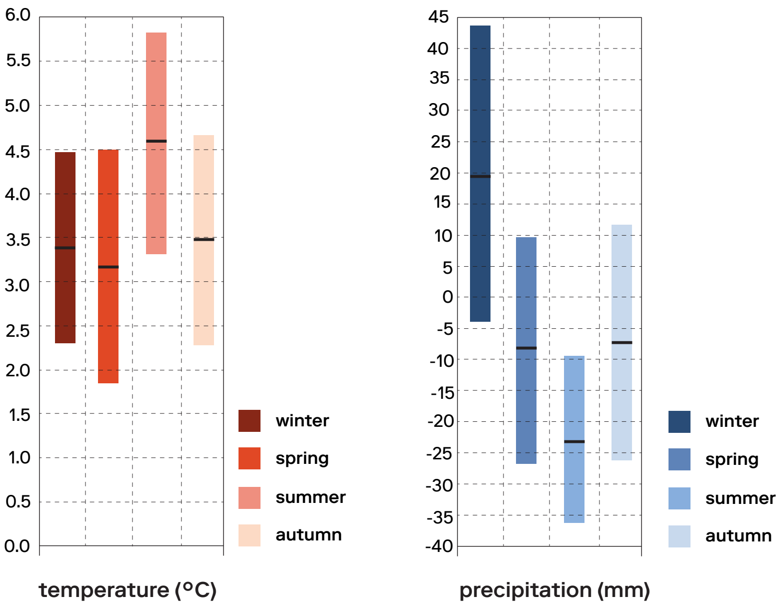


Fig. 5: Seasonal variation of temperature and rainfall in Valais untill 2070-2099 (compared with 1980-2009)

Agricultural productivity will face a lot more extreme weather events such as drought and flooding, which „will mean smaller harvests", notes Sandra Helfenstein, spokesperson for the Swiss Farmers' Union. To cope with this change, increasing the resilience and tolerence to the heat and drought are selection criteria for the choice of varieties.[7] Hence the notion of adaptive capacity which is the ability to mobilize resources adapting to climate change impacts. Engle argues that increasing this adaptive capacity enhances the opportunity to manage varying ranges and magnitudes of climate impacts, while allowing for flexibility.[8]

Endnotes
1 Kropotkin, P. (1902) Mutual Aid
2 Drought and Drought Mitigation in Europe, Jürgen V. Vogt and Francesca Somma
3 Marot, Sébastien (2020) Imagining and planning the energy descent, Marnes
4 Holmgren, David (2014) Permaculture. Principles and courses of action for a sustainable lifestyle, Paris, p.36
5 Varietal adaptations matter for agricultural water use – a simulation study T on grain maize in Western Switzerland, Annelie Holzkämper
6 Republik Zeitung, Conzett Anja, 2021 (Interview: Ilona Thétaz)republik.ch/2021/12/23/irgendwann-findest-du-dann-auch-fuck-you
7 https://www.sbv-usp.ch/fileadmin/sbvuspch/04_Medien/Medienmitteilungen/PM_2019/FOKUS03_FR_web.pdf
8 Engle, N.L. (2011) Adaptive capacity and its assessment. Global Environmental Change 21, 647–656.) https://www.cabi.org/cabebooks/Full-

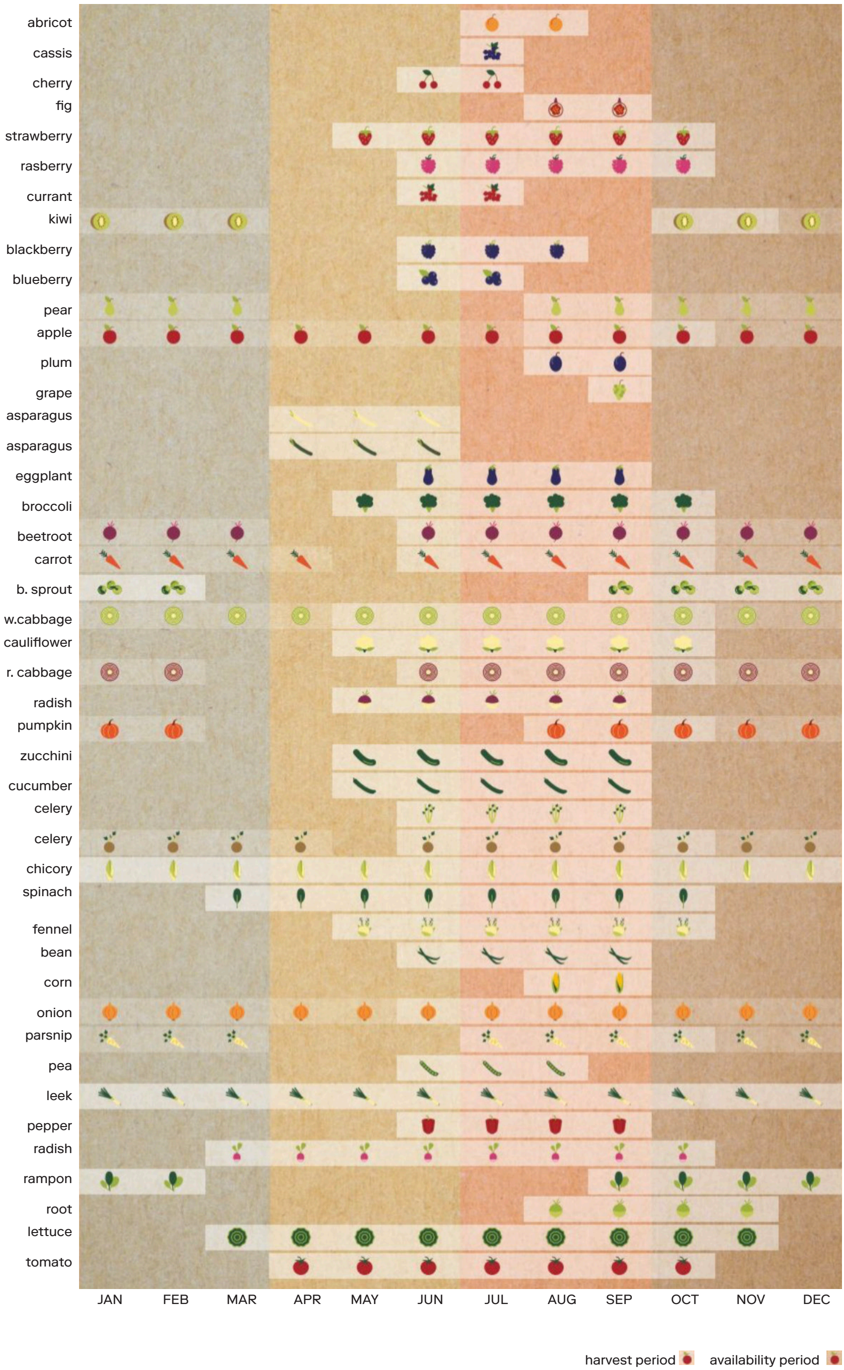


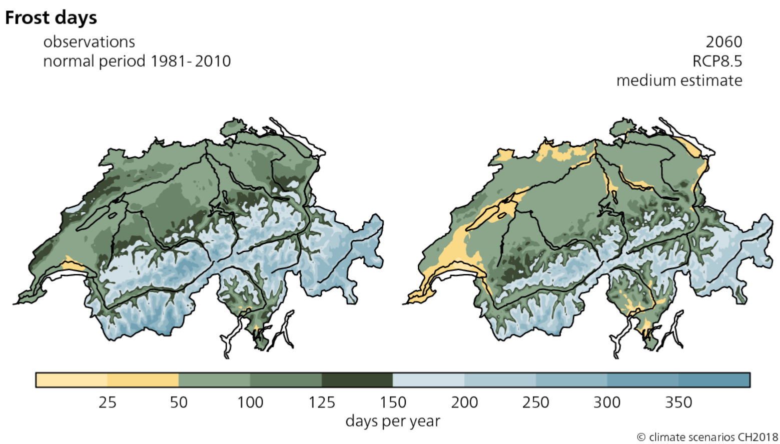
Fig. 6: Annual harvest and availability fruit chronolgy, VS

Heat-Cool

Whilst winters and early springs will become on average more temperate and mild under global warming, plant and blossoming will see temporal changes in their development. Eventhough the evolving scarcity of cold days will create more temperate thermic conditions in winter, cultivations will be at higher risk of spring frost and variability will create changing conditions and seasons of risk to below zero temperatures.

The extreme winter conditions and hazards that the inhabitants of the Valais have had to face have also been the devastating effects of the cold on agricultural production and the survival of winter. The Valais has a history of the strong combat against frost and the effects that this has had and will continue to have on agricultural production.

‚Frostbekämpfung', 1957, Valais

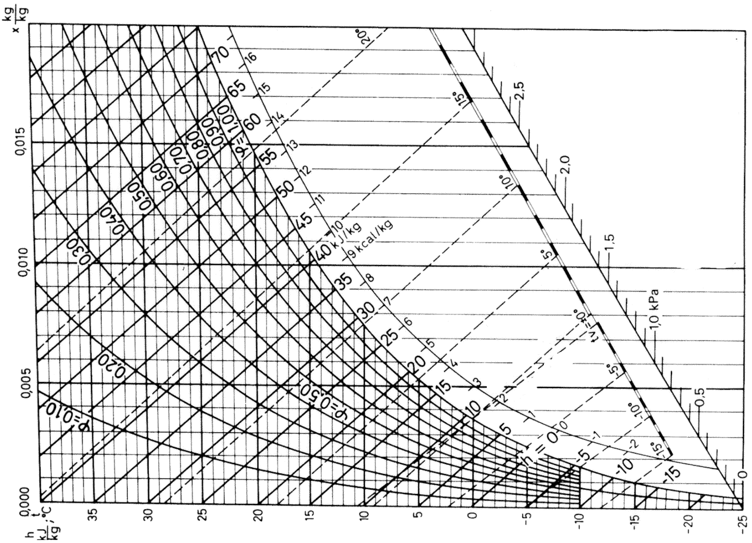


59 Frost Days 2060, RCP 8.5

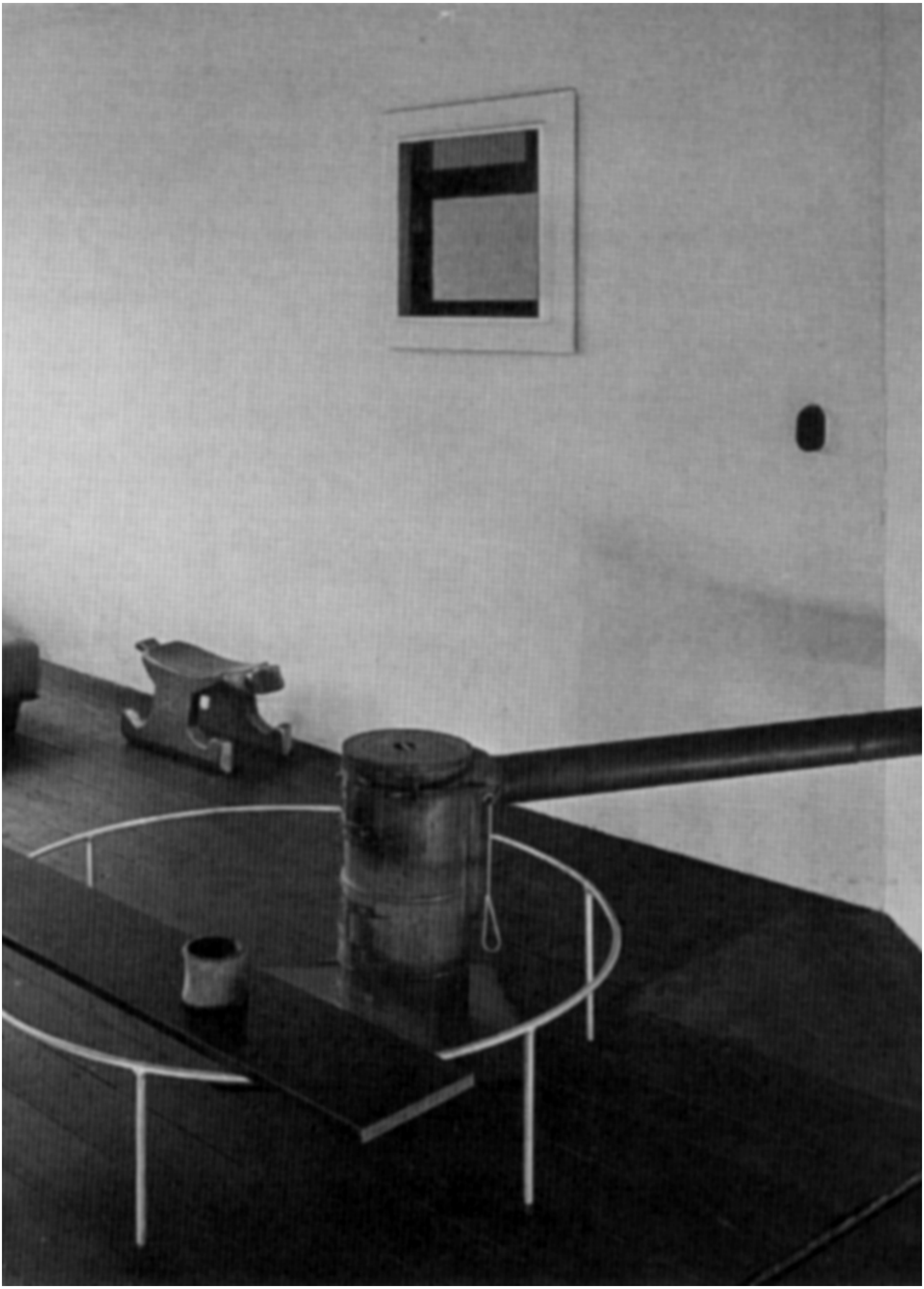
Heating

In summer, there will be a soaring necessity for air-conditioners and cool thermic conditions however the winters of 2060 will be milder, and heating needs will be less. Alpine conditions have long faced harsh winters and gathered around heat to brave the climate. Protecting us from these conditions, architecture keeps the cold away, captures or stores the heat.

Thermic inertia, orientation, insulation and heating are some of the means employed for the comfort of inhabitants. Heat transfer happens through the the processes of radiation, convection and conduction. With milder winter conditions, the idea is to eliminate heat and through exposure and insulation, create healthy living comfort.



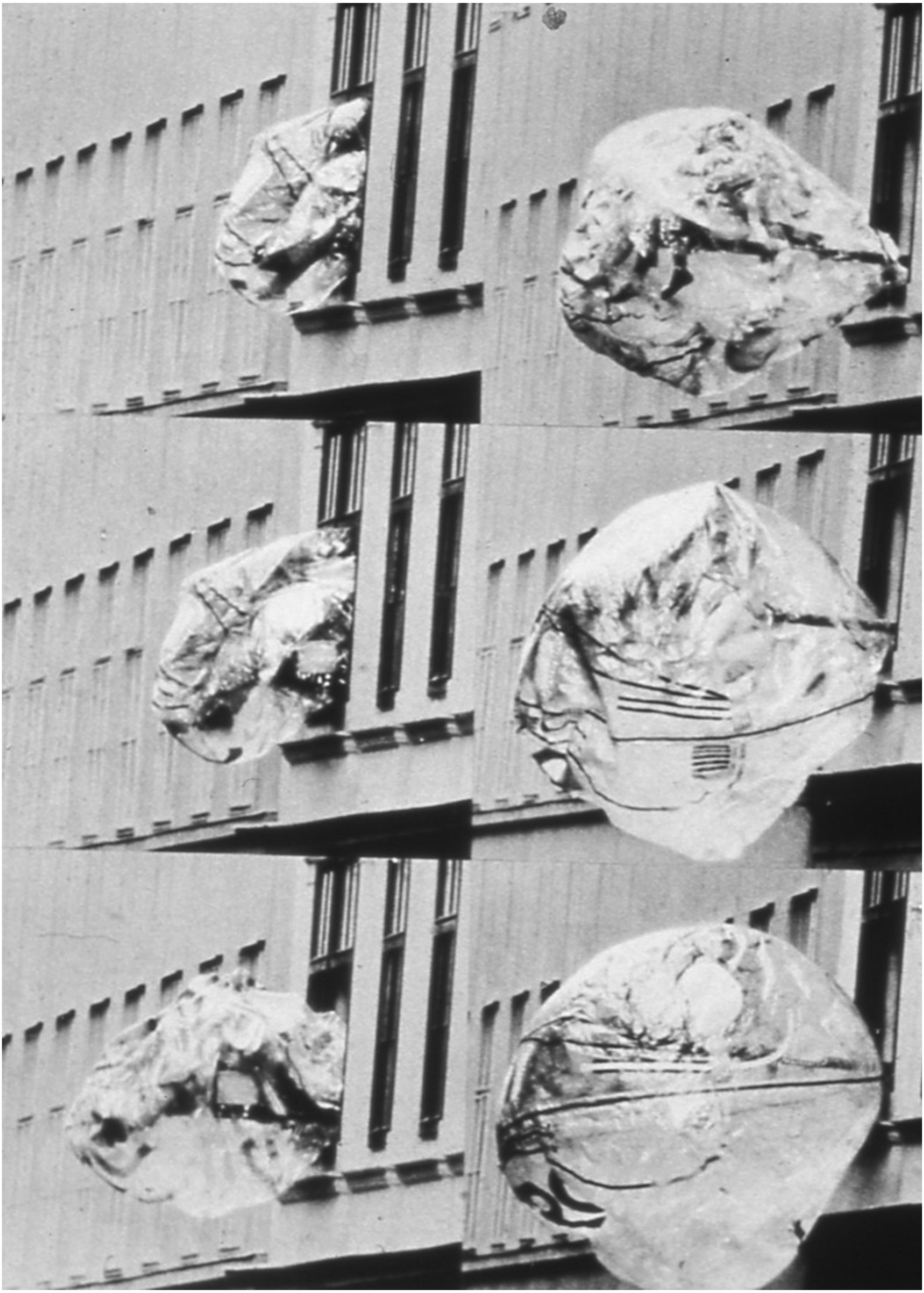
‚Frostbekämpfung‘, 1957, Valais



Aldo van Eyck, Stove in Apartment, Amsterdam

Heat transfer takes form through conduction, convection and radiation. Radiation for instance happens through emission and absorption and encompasses solar energy. Sun heats the earth by electromagnetic waves. Radiation is a process where heat waves are emitted and may be absorbed, reflected, or transmitted through a colder body. Looking at both architecture and agriculture, greenhouses capture this potential and thus create warmer thermic conditions through this radiation. The heat and light from the sun, allow a passive solar system being both cost-effective and energy-efficient.

The benefit of solar energy has also historically been used through walls with high thermal mass and southern exposure.



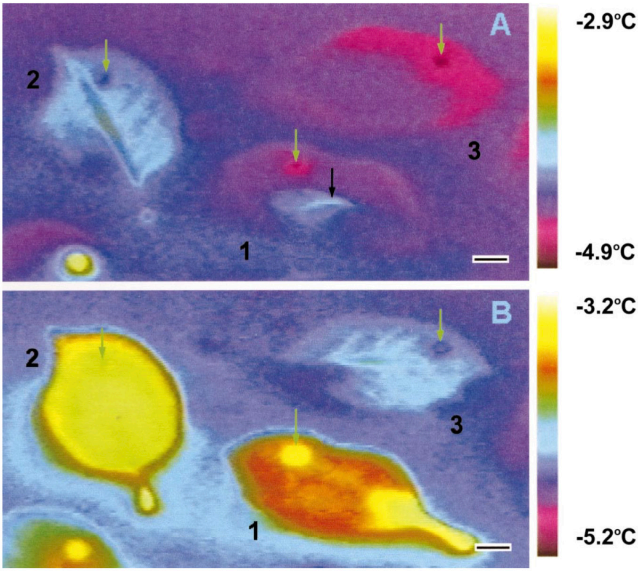
Haus Rucker-Co, Ballon für Zwei, 1969

Image: NASA, Frosted Terrain, 2016

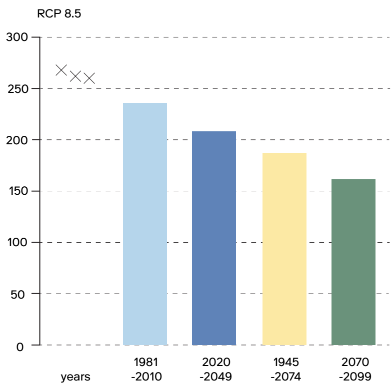
There may be milder winters coming, but blossoming flowers are at higher risk of frost because of longer growing seasons. If it is warmer, the plants flower faster and they are thus more susceptible to frost. The number of frost days, that are below 0°C, will decrease but the seasonal variability due to climate change extends risk and this combined to drought stress and water shortage creates tough conditions for agricultural productivity.

The cold months in Switzerland not only require farmers to combat the frost but other extreme weather events too. Ilona Thétaz, an organic farmer from the Valais, exclaims that this leads to "vegetables submerged in water, tubers and roots rotting in the soil, blossoms freezing to death on the branches, and what isn't frozen to death is bludgeoned by falling chunks of ice."[1]

The fight against frost used to illuminate the landscapes of the valley. Lighting candles and small fires at the stem of every tree was historically the solution to this struggle however this is now done with more efficient spray irrigation. Spray irrigation uses water and ice to protect the flowers and to preserve them. In horticulture, arboriculture and viticulture, water is used during the flowering period to combat frost by the sprinkling of water. The ice is there to protect the flowers and the frozen water acts as a barrier of protection. When the temperature drops, this water freezes and releases heat to its environment, some of which is to the still-ripening fruit. This heat is enough to preserve the fruit inside from freezing.



R. Pearce, 2000, Plant Freezing and Damage



67 Actual and future number of frost days (Tmin<0°C)

For frost damage to occur, the timing of early growth and blossoming in relation to low temperatures is pivotal. At the beginning of the year, spring is the most sensitive stages of development for the blooming of vegetation and the most exposed to risk. As this climatological frost conditions and growth conditions to the seasonal development of temperature, they are subject to the altering climatic conditions.[2]

Endnotes

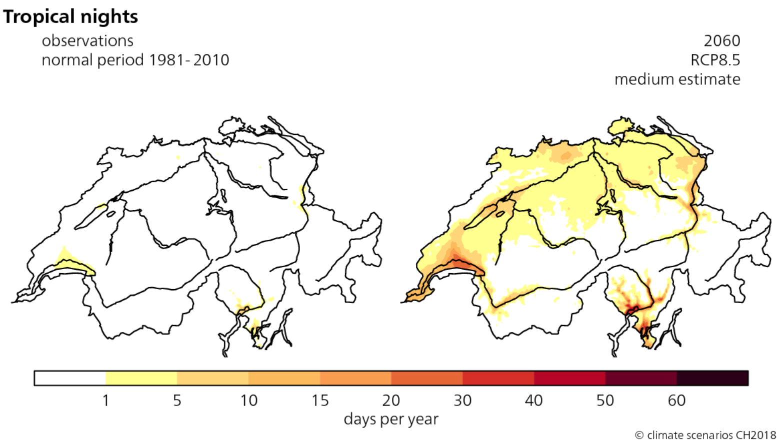
1 Republik Zeitung, Conzett Anja, 2021 (Interview:

2 Meier, M., Fuhrer, J. & Holzkämper, A. Changing risk of spring frost damage in grapevines due to climate change? A case study in the Swiss Rhone Valley. Int J Biometeorol 62, 991–1002 (2018). https://doi.org/10.1007/s00484-018-1501-y

Thermic deregulation with soaring temperatures will highly affect inhabitants comfort and nights sleeping in the tropical heat. We are conditioned by a thermic comfort defined by our bodies and this conditions our expectations, standards and productivity. Extreme heat will alter domestic standards and we will seek alternatives of inhabiting.

The Canton of Valais is the region of Switzerland that has seen the highest number of tropical days where maximum temperatures reach above 30°C, more specifically the city of Sion suffers from this critical heat. These tropical days will become increasingly frequent. As of the second half of the 21st century, longer periods of summer drought will be expected. These changes are largest at low elevations where the population density is typically highest, and heat stress may be further amplified by urban heat island effects.

Frostbekämpfung, 1957, Wallis



Tropical Nights 2060, RCP 8.5

Greater heat stress in agglomerations and cities is becoming an integral part of current discourse and future preoccupation. The place in Switzerland that has warmed up the most is Sion in the Canton of Valais. This has gained a wary eye from both inhabitants and the federal government.

Tropical nights and the degree day sum of 2121 will create the need to pursue alternatives to cooling that do not in themselves exponentially continue to heat the environment. ‚Cooling Degree Days' are expected to double by 2050, which will see the need for air-conditioning and cooling sky-rocket.

Evaporative cooling, specifically, evaporative air conditioning is the cooling of air by the evaporation of water. When water evaporates into the air to be cooled, simultaneously humidifying it, it is called direct evaporative cooling, the oldest and most common form. When the air to be cooled is kept separate from the evaporation process, and therefore is not humidified as it is cooled, that is called indirect evaporative cooling.

Looking at vernacular architecture in warmer climates, different kind of cooling and ventilation techniques have been historically employed. The orientation of architecture but also it's seasonal adaptation and rotation is of particular interest. Through thermic inertia and ventilation, comfortable living spaces are present and tend to the reduction of energetical consumption.

In vernacular persian architecture, the bagdir is a traditional element that uses the wind so as to create a natural ventilation system. This system works through normal atmospheric properties where warm air rises and decreases the air pressure within a room so that cooler air falls into the room. This produces the airflow necessary to make the room comfortably fresh in a hot climate.

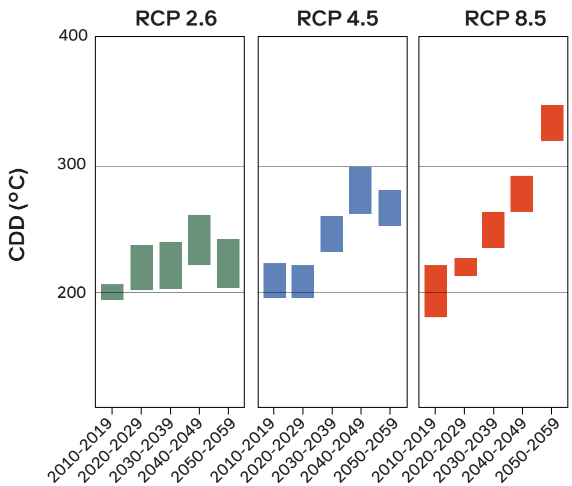
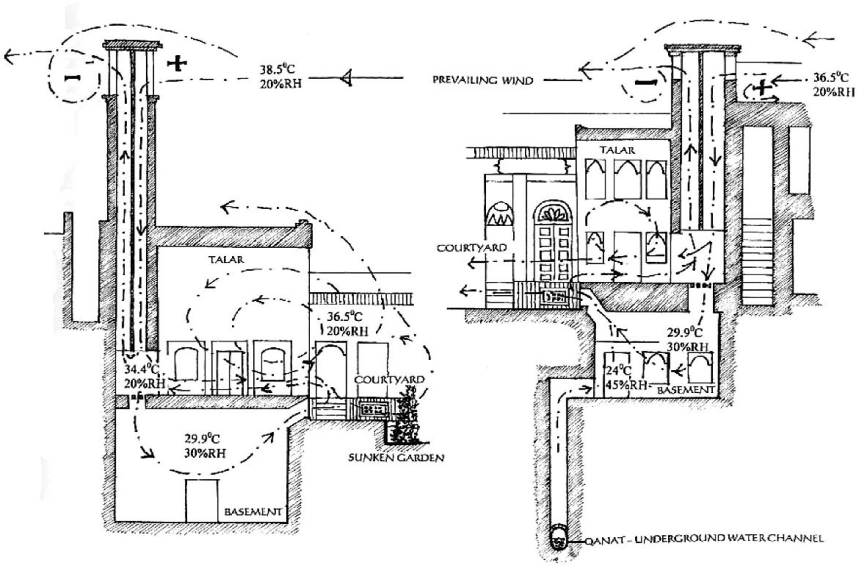


 Fig. A: Future annual mean Cooling Degree Days

“With the wind blowing air into the column by windcatcher, heat is transferred to the inner wall of windcatchers and finally cool air enters the building. The main advantage of a windcatcher is air-cooling without applying electrical energy.“[1] This vernacular element can also be combined with the technique of evaporative cooling in wetted wind-tower structures. This therefore uses both the wind and the capacity of evaporative cooling to create comfortable thermic conditions.

These passive energy systems and the potentiality of these wind towers can „save the electrical energy used to provide thermal comfort during the warm months of the year, especially during the peak hours.“[2]



 Source: Susan Roaf, The Windcatchers of Yazd, 1988

Susan Roaf, The Windcatchers of Yazd, 1988

Not only will there be less rainfall but there will also be quicker evaporation. This will result in the ground being dryer and more irrigation being needed. Less rain in the summer months is not the only bad news for farmers. Increasing temperatures will mean quicker evaporation. As a result, the ground will get dryer and more irrigation will be needed.

For the durability of agriculture irrigation is already a necessity in the Rhône plain and will be increasingly inevitable in the climatic conditions of 2121. The need for irrigation is increasing in Switzerland. Eventhough the Valais region lies amid the alpine peaks there is a periodic lack of water. Based on climate scenarios, the percentage of cultivated areas requiring irrigation in Western Switzerland, the Lower Valais and the small inter-alpine valleys would increase to 41%.[3]

In the Rhone plain, this irrigation water is mainly provided by groundwater. Wells, pumps and fixed or mobile sprinkler systems are used to irrigate the intensive crops in this region and also to combat frost. Higher temperatures may bring new possibilities and potentials but water supply and availability will be the obstacle and become increasing important. Water availability, however, will become even more important than it is today.

Endnotes

A https://www.sciencedirect.com/science/article/pii/S0306261921001719?via%3Dihub#f0045

1 Masrour, M., Abbasi, M., Hallaj, H, Study Of Windcatchers: The Mass Flow Rate And Inlet Air To The Building In Traditional Windcatchers, 2012

2 Dehghani-Sanij, Soltani, Raahemifar, A new design of wind tower for passive ventilation in buildings to reduce energy consumption in windy regions“

3 Fuhrer J., Jasper K., Water requirement for irrigation of grassland and crops in the current climate, Agrarforschung 16, 396-401, 2009

Research Question

How do the hazards and risks due to tropical nights and spring frosts form new potentials for thermic migration and cultivation as a common strategy for living together?

	hot	*cold*
architecture	**cool**	**heat**
agriculture	**drought**	**frost**

Appendix

Images: Extracted from ‚Forain Forever', Payot C., 2017

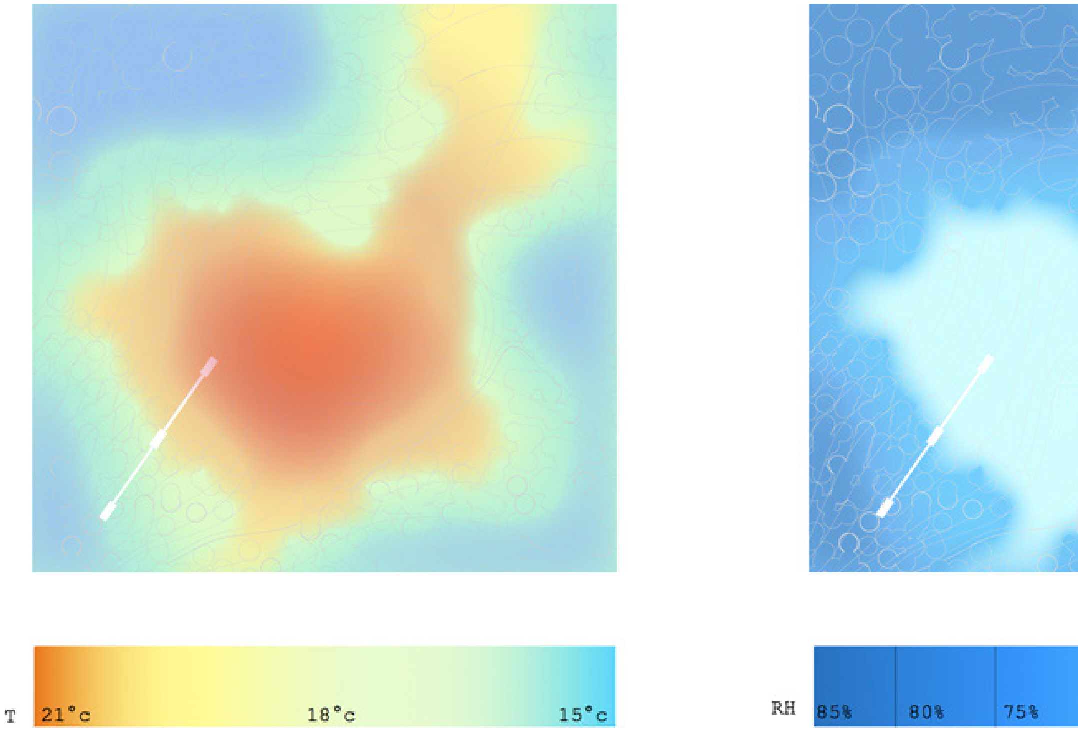


Fig. Philippe Rahm, House Dilation, 2006


70%
65%

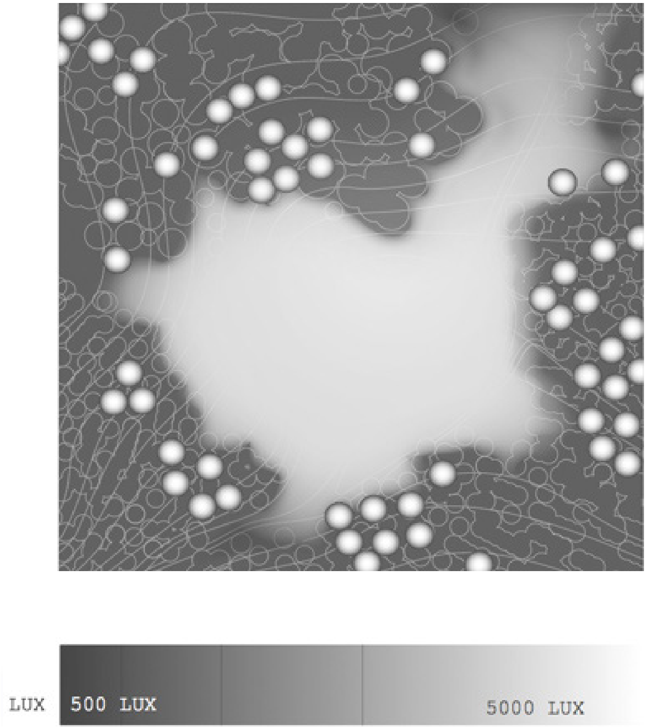

LUX
500 LUX
5000 LUX

Image: Crinkle Crankle Wall, Hilverbeek

Image: Greenhouse built against a serpentine fruit wall, Graveland

Bibliography

Books

- Crettaz, Bernard (1979) Nomades et Sédentaires dans le Val d‘Anniviers, Grounauer
- Holmgren, David (2014) Permaculture. Principles and courses of action for a sustainable lifestyle, Paris, Rue de l‘Echiquier
- Jacoupy, Jacqueline (1933) La Transhumance, Paris
- Kipfer, Werner (1977) Swiss agriculture illustrations
- Kropotkin, Peter (1902) Mutual Aid: A Factor of Evolution
- Latour, Bruno (1993) We Have Never Been Modern, Harvester Wheatsheaf, London
- Marot, Sébastien (2010) L‘Art de la mémoire, le ter ritoire et l‘architecture, Editions de la Vilette, Paris
- Marot, Sébastien (2020) Agriculture and Architec ture - Taking the Country‘s Side
- Office Fédéral de l‘agriculture (1983) Agriculture et économie alpestre dans le Valais romand
- Payot, Christine (2017) Forain Forever. Pour une goutte de vin, il faut bien descendre
- Reynard, E. (1995) Bisses irrigation in the Valais Geographical approach
- Swiss Farmers Secretariat (1962) Swiss agriculture
- Vogt, Jürgen V. and Somma, Francesca (2000) Drought and Drought Mitigation in Europe
- Wilhite, D. A. (1993) Drought Assessment, Manage ment and Planning: Theory and Case Studies, Klu wer Academic Publishers
- Wilhite, D. A. and Glantz, M. (1985) Understanding the Drought Phenomenon: The Role of Definitions
- Van den Muijzenberg, E. W. B (1980) A History of greenhouses
- Vessereau, Marcelle (1921) L‘Adret et L‘Ubac dans les Alpes Occidentales
- Vogt, G. (2021) Solid, Fluid, Biotic. Changing Alpine Landscapes, Lars Müller Publishers, Zürich

Articles

- Allgaier Leuch B., Streit K. and Brang P. (2017) „La forêt suisse face aux changements climatiques: quelles évolutions attendre?"
- Bigler, Bräker, Bugmann, Dobbertin & Riggling (2006) „Drought as an Inciting Mortality Factor in Scots Pine Stands of the Valais, Switzerland"
- Conzett, A. (2021) Republik Zeitung, Interview of Ilona Thétaz
- Crocetti L., Forkel M., Fischer M. (2020) „Earth Ob servation for agricultural drought: current state and future directions."
- Dehghani-Sanij, Soltani, Raahemifar, (2015) „A new design of wind tower for passive ventilation in buil dings to reduce energy consumption in windy regions"
- Engle, N.L. (2011) „Adaptive capacity and its as sessment. Global Environmental Change"
- Fuhrer J., Jasper K. (2009) Water requirement for irrigation of grassland and crops in the current cli mate, Agrarforschung 16, 396-401
- Holzkämper, A. (2020) „Varietal adaptations matter for agricultural water use"
- Kienast F. (1985) „Dendroecological studies on altitudinal profiles from different climatic regions"
- Marot, Sébastien (2020) Imagining and planning the energy descent, Marnes
- Masrour, M., Abbasi, M., Hallaj, H. (2012) Study Of Windcatchers: The Mass Flow Rate And Inlet Air To The Building In Traditional Windcatchers
- Meier, M., Fuhrer, J. & Holzkämper, A. (2018) „Chan ging risk of spring frost damage in grapevines due to climate change? A case study in the Swiss Rho ne Valley."
- Mutschler, Rüdisüli, Heer, Eggimann (2021) „Bench marking cooling and heating energy demands considering climate change, population growth and cooling device uptake"

- Swiss Farmers‘ Union (2019) „Swiss agriculture in the age of climate change“
- Swiss Federal Institute for Forest, Snow and Land scape (2020) Diagonal WSL Magazine, N°2
- Thornthwaite, C. W. (1948) An Approach toward a Rational Classification of Climate (https://www.jstor.org/stable/210739?seq=48)
- Ward, de Ruiter, Mård (...) (2020) „The need to integ rate flood and drought disaster risk reduction stra tegies“, (https://www.sciencedirect.com/science/article/pii/S2468312420300109)
- Synthesis Document, Climatic Change in Valais, Canton du Valais
- NCCS (2021) Water management, Impacts of cli mate change on the water balance„Soil humidity and evaporation“

Renewable and Sustainable Energy Reviews,

Lectures/Interviews

- Hampe, M. and Sauter F. (2014) Panta Rhei and Pla tos Revenge
- Jean-Christophe Clivaz, Dipl. Forestry Engineer ETH, Head of the Service for Forests, River Engineering and Landscape, Canton of Valais, 29.03.2022
- Georg Bregy, MSc ETH Agronomic Engineer / MBA, Service for Agriculture Canton of Valais, 30.03.2022
- Dr. Sc. Nat. ETHZ Pierluigi Calanca, Agricultural/ Climatolgy Expert Agroscope, Institute of Research, Federal Office for Agriculture, 06.04.2022

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