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ARCH 407/507 Human Factors & Research Methods

Are native desert plants appropriate for green roofs in Portland, Oregon?

Introduction

Studying and designing roofs for years as a part of my professional career as an architect shows me the similarity between desert environment and the environment of roofs and leads me to the question: Is planting desert plants on Portland's green roofs an appropriate solution? Conditions on Portland's roofs are often very similar to those found in the desert. Most roofs are exposed to the sun without any shading. Long drought periods occur during the summer season, even here on the west side of the Cascade Mountains. The unprotected surfaces are exposed to the elements and drastic temperature changes are typical. Rainfall drains fast from the sloped roofs and little moisture is stored even during the rainy seasons.

To prove the assumption that desert plants are suitable for Portland's roof landscape, I will research the climate conditions of the desert in the Northwest and their vegetation. In comparison to the desert, I will also research the city climate and the conditions on Portland's roofs. The research is mainly supported by the use of publications.

Desert

To get a better understanding of the climate and conditions of the desert, we should start with the definition of this unique landscape. The World Book Encyclopedia describes the desert as a generally hot, barren region that receives little rainfall, but at the same time is not waste land. Checking the German encyclopedia "Der Brockhaus in einem Band", I find a slightly different description. The desert is a landscape with little or no vegetation. There are cold deserts, dry deserts and hot deserts. In the last two, the evaporation is higher than the rainfall. Deserts are exposed to extreme daily temperature changes. Seldom rainfalls are often heavy.

Very little of the Oregon desert is a true desert, as defined by scientists. Any desert has a rate of evaporation at least seven times that of precipitation, as described in the Oregon Desert Guide by Andy Kerr. The driest spot in Oregon is Andrew at the east side of Steens Mountain, where the annual precipitation is usually not higher than seven inches. Burns, located north of the Malheur National Wildlife Refuge, receives around 12 inches of precipitation a year. The climate can be described as harsh, but healthful, with hot dry summers and cold dry winters. The minimal precipitation comes primarily as snow and during infrequent summer thunderstorms. But the averages vary more than elsewhere in Oregon. For example, the record high for Andrew is 107

degrees F, while the low is a frigid 33 below zero. Burns' average precipitation of 12 inches per year decreased in 1937 to only six inches and topped 17 inches in 1940.

Comparison of the climates between Eastern Oregon and Portland, Oregon

October is a big transition month in Oregon. Early in the month, mild "Indian Summer" days are common and the probability of precipitation in western Oregon is only about 30%. By the end of the month, early winter has arrived. Precipitation probabilities have risen to 60%. The temperature has dropped consistently and there is a chance for the season's first frost. The wettest month in Oregon is December and January (Oregon Climate). The following comparisons of Portland and the South Central Area of Oregon, which was published in The Climates of Oregon, show the monthly precipitation and temperatures of both areas.

Monthly and annual precipitation (in inches). 1961-1990 means.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Portland	5.36	3.85	3.56	2.39	2.06	1.48	.63	1.09	1.75	2.67	5.34	6.13	36.32
Mitchell	.86	.65	1.04	1.13	1.55	1.25	.57	.78	.74	.75	1.23	.99	11.57

Monthly temperatures (F)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Portland	45.2	51.2	56.0	59.9	67.1	73.6	79.8	80.1	74.0	63.8	52.4	45.8	62.4
	33.6	36.5	38.5	41	46.8	52.8	56.4	56.8	51.7	44.7	39.2	34.9	44.4
Mitchell	41.3	47.1	52.9	59.8	68.0	77.5	85.8	85.3	75.8	64.6	48.9	41.5	62.7
	23.6	27.1	30.4	33.4	39.4	46.8	51.0	50.7	42.7	35.3	29.2	24.4	36.5

Station and Elevation

Portland / WSPO AP 20 feet

Mitchell / South Central Area 2600 feet

A study in Germany shows that flat roofs with gravel protection can heat up to 60 C (+/-140 F) and more if the air temperature is just 25 C (77 F) (Daecher begruenen einfach und wirkungsvoll). The temperature in Portland in the summer months is similar to Berlin, Germany.

Vegetation of the Oregon desert

At one time eastern Oregon was semitropical. Rainfall was heavy. Growth was lush and lakes and swamps made ideal homes for rhinoceros and elephant-like animals that could only live where vegetation is plentiful. Than lava began to flow; eastern Oregon was cut off from the western part and rising mountain chains were formed. The tension grew untill one part was falling down and the other part was lifted up. The Cascade Mountains were formed and cast all of

eastern Oregon into a drought shadow three hundred miles wide. At that point, the vegetation had to change. Ferns, redwood and other moisture lovers had to leave. The new-formed desert filled slowly with plants, which we can find today throughout the Oregon desert. The authors of “The Oregon Desert”, Jackman and Lang, say that plants had to follow three main rules:

1. The color must be predominately gray. It can be gray-green or gray-blue.
2. The plant must be unattractive to animals, including buffalo, elk, antelope, deer and rabbit. This rule worked until the white settler arrived. Plants which were avoided by native animals were unfortunately not disliked by the horse, cow, sheep or mule.
3. Plants must have some moisture –saving devises. Leaves have often a small surface and have the ability to hold water instead of passing it off into the air. Some plants like rabbit brush are dormant during dry years, making no growth at all; junipers have modified scales instead of leaves; the annuals bear seeds quickly in the spring and die; larkspur has its showy flowers in May, the top dies and the deeply buried crown sends up a new top next year. Perennials, such as sagebrush, must have small leaves, not divided much, with smooth or nearly smooth margins, and plants have a large proportion of wood to leaf. Desert plants are ingenious in working out water-saving schemes. Root, stem and leaf all work together on the project. Even the seeds get into the act.

Water management in the desert

Many deserts have at least one permanent stream (World Book Encyclopedia). The encyclopedia refers to the Nile as an example. Other examples would be the Deschutes River in Oregon’s high desert or the majestic Columbia River in eastern Washington and Oregon. Undisturbed stream banks are usually filled with trees and shrubs, which provide shade for the water and even allow trout to live in the desert environment. Frequently rain showers are draining into temporary lake beds, streams and they evaporate in quickly. Vegetation is playing an important role to store water for itself. Sometimes if the water table is high enough, oases are formed.

Green roofs

Green roofs have been known for centuries. Today with the knowledge about our impact on the environment and the occurring changes, green roofs seem to be one of many tools to fix some of the problems we created. Green roofs help reduce both the overheating of our cities and the dust and pollution of the air. Green roofs are also energy savers. They act as a natural insulation in both the summer and winter.

There are different definitions in use. The U.S Environmental Protection Agency defines green roofs as vegetation growing on soil or a growing medium planted over a waterproofing membrane. Additional layers of root barrier, drainage and irrigation could be included.

Often green roofs are divided into “Intensive Planting” or “Extensive Plantings”. The intensive method is usually plantings of shrubs, plants and grasses as they are used in plantings on grade. The growing medium is at least one foot deep and needs irrigation and the addition of soil nutrition. It is cost and labor intensive. A more efficient solution is the use of “Extensive Plantings”, which has two to five inches of growing medium and no additional irrigation or nutrition needs. Drought resistant plants, which produce roof coverage, are used.

Green roof detailing for the use of native plants

As described above, native desert plants are well suited for a dry environment. From the end of May until the beginning of September, Portland has a drought period similar to Oregon’s desert. The precipitation is just around one inch per month during this time. Roofs are exposed to the sun and wind. The temperature changes on the roof surfaces are much higher than anywhere else in the city environment. The conditions seem to be right for native desert plants. **During the wet months from October to April the performance of green roofs requires more attention.** The precipitation is much higher than in the desert during this time period. Sloped roofs seem to be ideal for planting native desert plants. Slope roofs drain fast and the wind will absorb the moisture. It is important to avoid standing water for a longer period. A drainage layer can help to drain the excess water. Important is also an efficient insulation of the roof, especially if the rooms underneath are heated, to create similar conditions to the cold desert in the winter.

Conclusion

Green roofs are important for the climate of our cities and are also an important tool to save energy. As described above, they can be very successful especially in Portland, Oregon. The key is to find the right planting and a functional design for the green roof in our environment. Roofs are in most cases exposed to the sun and have much higher temperature changes than the surrounding environment. They are exposed to the elements and have a similar environment to the desert. Native desert plants seem to be a natural for Portland’s green roofs. Native desert plants are able to survive harsh conditions, characterized with long drought periods, extreme temperature changes and windy conditions – all of which are found on Portland’s roof landscape. When it comes to working out water-saving schemes, desert plants are very ingenious.

Critical are the wet winter months, when the precipitation reaches a peak of six inches and more per month. **Roofs have to have an efficient slope through which the excess water can drain so the plants do not drown.** A drain layer will help to prevent standing water, which is very crucial especially for desert plants. The extensive roof, with a soil depth of 2-5 inches, is the most suited solution for green roof plantings with native desert plants.

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Portland, 12/01/05