Establishing a Snow Survey in the State of Hessen, W. Germany

by

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INTRODUCTION

Hessen is one of the Länder, or autonomous states of the Federal Republic of Germany. In its present form, it includes an area of about 8,150 square miles (21,110 km^2), about the size of Massachusetts. The population in 1967 was 5.25 million with an average density of 645/square mile and a range from 28 to 9,065/square mile. Major cities include Frankfurt, Wiesbaden, Darmstadt, Kassel, Offenbach, and Giessen.

Thirty percent of the total area of the state is in cultivated land and gardens, sixteen percent in meadow and pasture, and almost 41 percent in forest. The forest land is not uniformly distributed over the land, but it is very rare to see a landscape where no forested uplands are visible. Hardwood and coniferous stands make up an approximately equal part of the forested area at present. This was not always so. Two hundred years ago the forests were largely hardwoods, mostly Beech and Oak, with a significant proportion of Ash, Maple and other deciduous species.

Hessen is generally a rolling upland, broken by hills and eroded mountains. The lowest elevations, less than 80 meters above m.s.l., are in the Rheingau and the highest point is the Wasserkuppe in the Rhön at 950 meters. A variegated sandstone is the bedrock over a broad area from the southern boundary of Hessen in the sedimentary Odenwald to the Reinhardswald in the most northerly district. The lowest elevations are underlain by Tertiary sands and gravels with some limestone. Some of the highest elevations in the State are basalt mountains such as the Rhön, Vogelsberg and Landrücken. The crystalline Odenwald, the Schiefergebirge, the Kellerwald, Taunus, and Spessart are underlain by schists.

Precipitation in Hessen varies according to relief, nearness to the ocean and relation to the general westerly wind and Atlantic weather. Average annual precipitation is 720 mm (28.5 in) with a summer maximum in the lowlands and usually a winter maximum at high elevations. Dry year annual totals in the Rhein-Main area may be lower than 300 mm (11.8 in) and in very wet years some of the northwest mountains may receive more than 1,800 mm (70.9 in)

THE PROBLEM

Although there are about 380 precipitation stations fairly evenly distributed over Hessen, it is recognized that this does not provide adequate information for all Hydrologic purposes, especially for flood warning. Snow depths and water equivalents have been measured at some Weather Service Stations (using the Hellmann snow sampler, a device similar to a standard raingage with a sharp cutting edge), but no general information on variation, cover effects, persistence or elevation has been developed.

In cooperation with the Hessian Forest Ranger School at Schotten, snow survey planning data was gathered in the winters since 1967-68 at one-to-two week intervals under young, mature and old stands of Beech and Norway Spruce, and on open land in the western Vogelsberg. This series of studies indicated that the greatest snow accumulation occurred in Beech stands on north and east facing slopes, in average years, and that although accumulation increased with elevation (Brechtel 1970 and 1972) the snowpack was also important at elevations below 300 meters.

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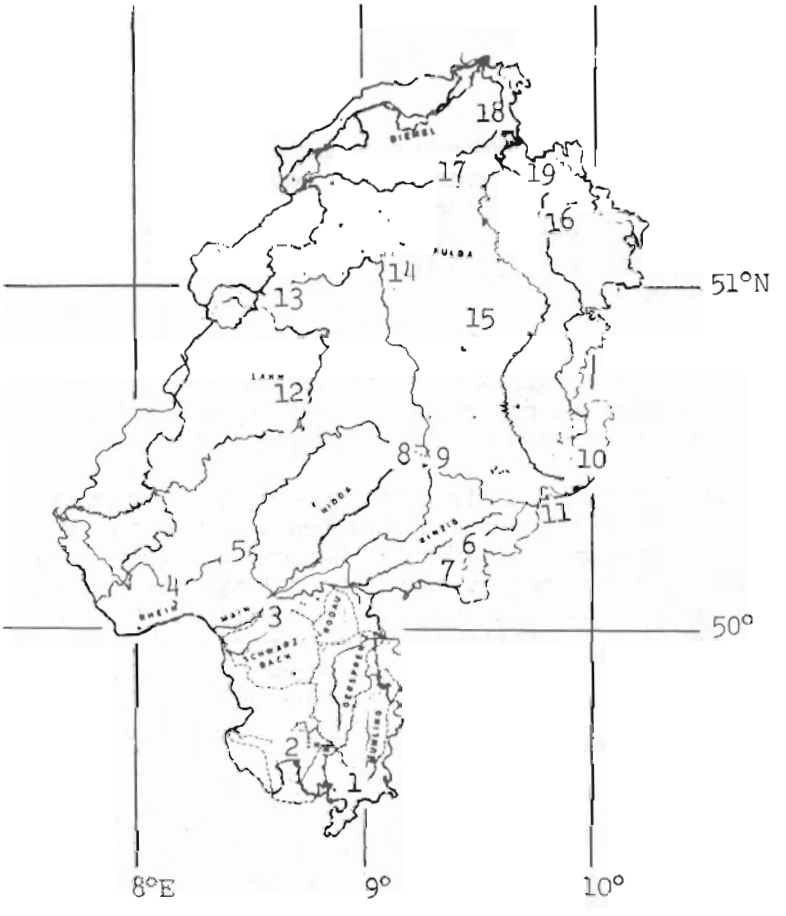

Figure 1. Map of Hessen showing major watersheds and groups of snow course locations. (See Table 1 for location names)

Political boundary ----------

Watershed Boundary and name of stream LAHN

Stream Channel

Scale

0 Kilometers 100

Miles

0 50

TABLE 1. SNOW COURSE LOCATIONS AND SITE CHARACTERISTICS

Area No. 2/	Survey Area	SNOW COURSES		
		Exposi-- tion	Elevation Meters Above MSL.	Number of Courses
1	Sedimentary Odenwald	N,S	200-500	21
2	Crystalline Odenwald	N,S	100-600	34
3	Frankfurt City Forest	LEVEL	100	22
4	Southern Taunus	N,S	200-600	40
5	High Taunus	N,S	100-900	44
6	Klingbachtal	N,S,E,W	200-500	31
7	Hessian Spessart	N,S	200-500	17
8	Western Vogelsberg	N,S	100-700	50
9	Eastern Vogelsberg	N,S	300-700	35
10	Rhön Uplands	N,S	300-900	47
11	High Rhön	N,S	400-800	22
12	Krofdorf	N,S,E,W,	200-300	20
13	Hess., Schiefergebirge	N,S	300-700	37
14	Kellerwald	N,S	300-800	41
15	Knullgebirge	N,S	300-600	28
16	Meissner	N,S,E,W	300-700	58
17	Habichtswald	N,S	200-600	33
18	Reinhardswald	N,S,E,W	200-400	54
19	Ziegenhagen	N,S,E,W	300-500	25
20	Observation Stations of the German Weather Service		100-900	37

2/ These numbers refer to numbered locations on Figure 1.

THE SNOW SURVEY

In July of 1971 with funds provided by the Deutsche Forschungsgemeinschaft (German Research Union) Dr. Brechtel prepared a work plan which, with cooperation from the Hessian Forest Service, the German Weather Service and the Hessian Central Office for Data Analysis, would make possible an orderly, systematic, sampling of the snow cover on specified mountain masses and determination of the variation associated with differences in aspect, slope, elevation and vegetation cover type.

The Hessian Forest Service is the agency responsible for administration of all the forest land, public and private, in the State. Its organization has easy access to, and is familiar with the highland areas where the snowpack may represent a potential problem or be a significant source of water for groundwater recharge and/or streamflow.

With the help of the responsible forest officers and district rangers, snow courses were laid out at 100 meter elevation intervals on north and south slopes under Beech, and Spruce stands and open land conditions in 12 physiographic areas of Hessen. (Figure 1, Table 1). Six hundred and fifty-nine courses, approximately twenty to thirty meters long, each made up of ten sample points were laid out in this way. In addition, 37 snow courses were established adjacent to regular climatic stations of the German Weather Service. These last lines were to be measured by the Weather Service observers. This then made a total 696 courses in all. In some areas where local interest was strong or other hydrologic research was being carried on, observations were planned on east and west slopes as well as the north and south. (Table 1).

In addition to snow depth and water equivalent, observations on the weather conditions, snow in the crown and on the ground, and depth of soil frost were also to be made and recorded on the mark-sense card designed by the Central Office for Data Analysis (Figure 2). Those observations were to be made every Saturday from January to March for the first few years. If no snow was present, the card was still to be filled out and sent in. On Saturdays in November and December or April and May when measurable snow was on the ground, measurements were to be made, also.

Snow samplers to be used were similar to Adirondack Snow Tubes--120 cm long with steel cutting bits and an opening with a cross sectional area of 25 cm^2. They were made of transparent PVC tubing with inscribed centimeter markings. A cylindrical sensitive spring balance with a maximum capacity of 2.5 kilograms was to be used to weigh snow and tube.

An observer corps was trained from members of the Hessian and German Forest Services and the German Weather Service on the first snowfalls of the winter of 1971-72.

PRELIMINARY RESULTS

Unfortunately the first winter (1971-72) very little snow fell and the only sampling date worth examining closely was the 29th of January. On this date there was no measurable snow below the 300 meter line except in the southern Taunus where approximately 20 mm water equivalent, on the average, was found on north and south aspects under Beech, on north slopes under Spruce, and on south facing meadows. Maximum average accumulations were about 40 mm water equivalent on open land at 800 meters in the high Taunus and at 700 meters under Spruce on southern slopes in the Meissner. On the Frankfurt city forest, which is on fairly level land at 100 meters elevation, Klingbachtal, Krofdorf, and most of the observation stations of the German Weather Service snow was too low to measure (less than 10 mm water equivalent) or was totally lacking.

The past year's results may have some value in defining the lower extreme of the expected snow accumulation. 1971-72 was a winter of very low snowfall over most of Europe. Hopefully, experience will be gained in the next few years to indicate the value of this snow survey for planning forestry work, winter recreation, water management and flood warning.

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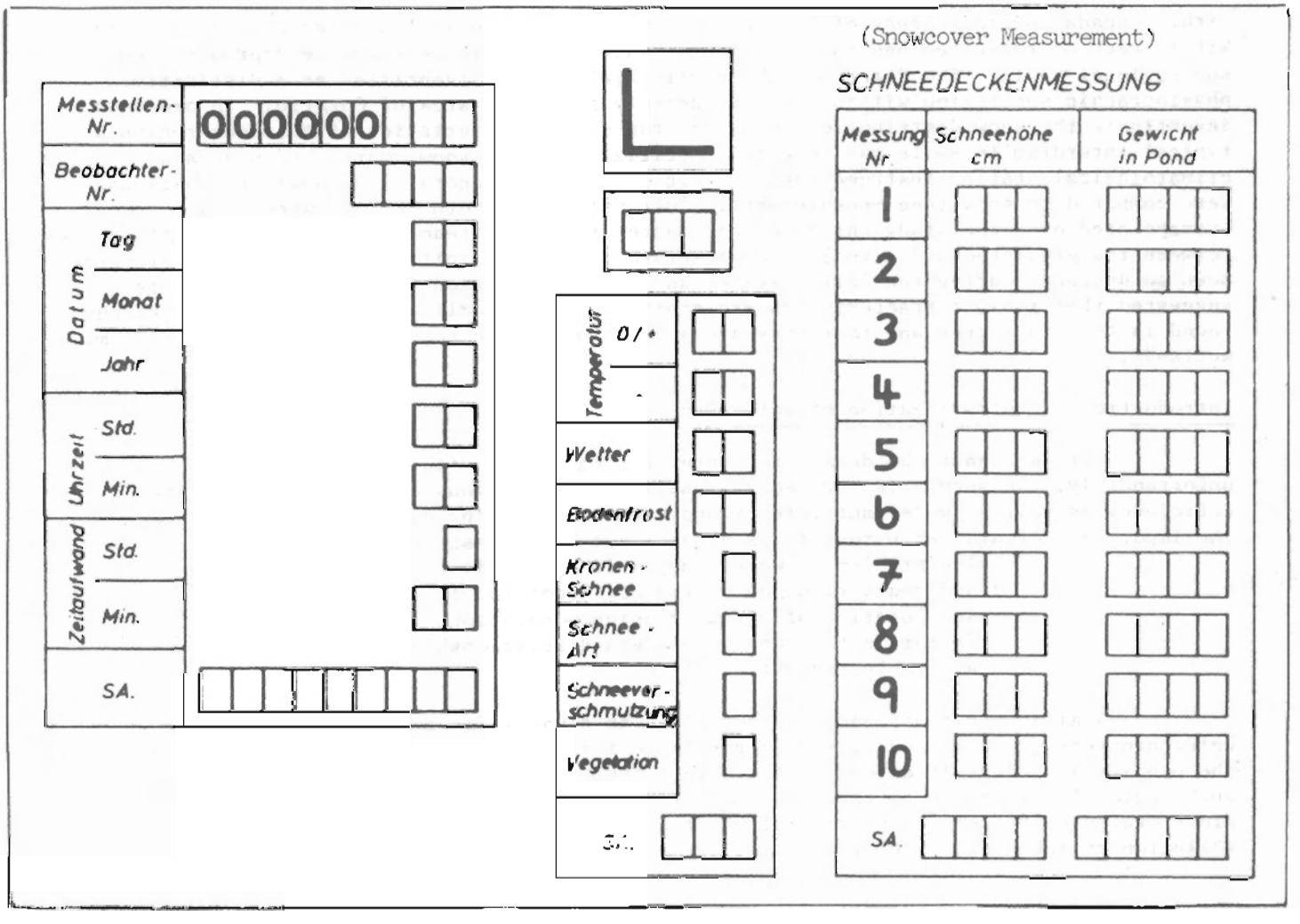

KEY

Wetter
(Weather)

1. Sunshine
2. Cloudy
3. Overcast
4. Raining
5. Snowing
6. 4 + 5 mixed

Schneehöhe
(Snow depth)

Gewicht
(Weight)

Kronenschnee
(Snow in tree crowns)

1. Snow free
2. Little snow
3. Much snow
4. Frost or rime

Schneeverschmutzung
(Degree of snow soiling)

1. None
2. Slight
3. Much

Schneeart
(Type of snow on ground)

1. Powder snow
2. Wet snow
3. Crust
4. Granular

Vegetation

1. Beech
2. Spruce
3. Open land

Figure 2. Mark-sense card for field observation.