

**GUIDELINES FOR
PRELIMINARY
GLACIER INVENTORIES**

**Temporary Technical Secretariat
for the
World Glacier Inventory**

A Project of Global Environment Monitoring System	GEMS
United Nations Environment Programme	UNEP
United Nations Educational, Scientific and Cultural Organization	UNESCO
International Commission on Snow and Ice	ICSI
Swiss Federal Institute of Technology Zurich	ETH-Z

Guidelines
for
Preliminary Glacier Inventories

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World Glacier Inventory

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1. Introduction

In 1976, the Temporary Technical Secretariat (TTS) for the World Glacier Inventory was founded by Prof. Fritz Müller, Director of the Department of Geography, Swiss Federal Institute of Technology (ETH), Zürich. Support for the project was provided by the United Nations Environment Programme (UNEP), UNESCO, the International Commission on Snow and Ice (ICSI) of the International Association of Hydrological Sciences (IAHS) and ETH. Since then, considerable progress has been made in preparing inventories of the world's glacierized areas. A Workshop on the World Glacier Inventory was held at Riederalp in September 1978 at which some 60 scientists provided a further stimulus to the work.

In preparing each inventory, correspondents more or less followed the 'Instructions for Compilation and Assemblage of Data for a World Glacier Inventory' issued by the TTS in 1977. These instructions were based on the UNESCO/IAHS (1970) publication 'Perennial Ice and Snow Masses' (Technical Paper in Hydrology, Vol. 1). It was found that the Instructions could be used for a wide variety of glacier types, even though some shortcomings gradually became obvious.

In July 1980, Prof. Fritz Müller died suddenly. Since then the TTS work has been carried on by his assistant, Mr. Karl Scherler, who had been actively involved in the project since 1977.

A Review Meeting on the World Glacier Inventory which was convened in August 1981, noted the accomplishments of the project and identified a number of obstacles which were impeding progress. A deadline of 31 December 1985 for completion of the World Glacier Inventory work was agreed upon by meeting attendees.

In order to realistically achieve this 1985 deadline, however, the 'Instructions for Compilation and Assemblage of Data for a World Glacier Inventory' should be supplemented by guidelines for preliminary glacier inventories. It was also decided that the guidelines should provide for the use of simpler methods of compiling basic data on glaciers, such as could be derived from analysis of satellite imagery. A working group was set up to tackle this task. This group consisted of Dr. G.Patzelt, Innsbruck; Prof.Dr. G.Oestrem, Oslo and Stockholm, Dr. M.F.Meier, Tacoma, U.S.A., and Mr. K. Scherler, Executive Secretary of the TTS.

At the Government Expert Meeting on Climate Related Monitoring which was held at the WMO offices in Geneva in

March 1982, it was suggested that the group should be enlarged by experts on continental ice masses and by specialists in satellite imagery, and that another special meeting should be in Zürich during the later part of 1982.

The Expert Meeting on Preliminary Glacier Inventories took place at TTS offices in Zurich in October 1982. Participating were Mrs. L.Espizua de Bengochea, Instituto de Nivologia y Glaciologia, Mendoza, Argentina, Dr. G.Ostrem, N.V.E., Oslo, and Stockholm University, Dr. C. Swithinbank, British Antarctic Survey, Cambridge, U.K., Dr. A.Weidick, Geological Survey of Greenland, Copenhagen, Dr. R.S.Williams, Jr., EROS Office, U.S. Geological Survey, Reston, Va., Dr. C.C.Wallen, UNEP/WMO, Geneva, Dr. I.I.Snezhko, UNESCO, Paris, and Mr. K. Scherler, TTS. The main result from this meeting was the development of a new set of Guidelines for Preliminary Glacier Inventories. The author is greatly indebted to all participants of the meeting for their valuable contributions. Dr. Swithinbank and Dr. Williams edited the present guidelines carefully.

2. The Guidelines for Preliminary Glacier Inventories

2.1. The Purpose of the Guidelines

The new guidelines are not intended to replace but rather to supplement the 1977 'Instructions for Compilation and Assemblage of Data for a World Glacier Inventory'. All scientists involved in the compilation of a 'standard' glacier inventory are encouraged to continue this work. If, and only if, it is evident that the completion of a 'standard' inventory before the end of 1985 is impossible, then a preliminary glacier inventory should be compiled.

In addition, the new Guidelines should also serve to encourage those scientists who have not yet started a glacier inventory because of the rather ambitious and somewhat intimidating 'Instructions' for compiling a full glacier inventory. A preliminary inventory need not be a time-consuming job. It is hoped that new inventories can now be started in the very few regions where little or no such work has been done so far.

2.2. Base Material

Most glacierized regions are now covered by suitable satellite imagery; exceptions may be in some mountain regions which are usually cloud covered, or regions beyond the coverage area of a particular satellite. The imagery is relatively easy to acquire through various national data centres, such as the EROS Data Center in the United States. Moreover, a number of institutions working in the fields of glaciology, hydrology, or related fields, already archive satellite imagery of their geographic area of interest. A list of scientists and institutions involved in the Satellite Image Atlas of Glaciers Project, is given in the appendix (by Dr. R.S. Williams, Jr., Editor, Satellite Image Atlas of Glaciers, U.S. Geological Survey, Reston, Va., U.S.A.). Another appendix provides the addresses for national archives of Landsat imagery and a map showing the reception radii for Landsat receiving stations. The guidelines assume the use of satellite imagery but the use of other data sources, such as aerial photographs is also encouraged.

2.3. Levels of Preliminary Glacier Inventories

The Expert Meeting defined FOUR LEVELS for such inventories:

L e v e l 1

(only satellite imagery needed)

- Total glacierized area of the country
(equal to white area on suitable satellite imagery)
- Accuracy rating
- Source of information:
 - type of satellite imagery
 - date of satellite imagery
 - resolution of satellite imagery
 - quality of satellite imagery
(shadows, snow cover, etc.)

L e v e l 2

(only satellite imagery needed)

- Surface area of individual glacierized areas on satellite images (cloud free, end of ablation season)
- Geographical coordinates (latitude and longitude for the centres of such areas)
- Name of ice-cap or mountain group
- Simple classification
 - mountain glaciers
 - ice cap
- Source of information
 - cf. Level 1

L e v e l 3

(only satellite imagery needed)

- Surface area of individual glacier units with accuracy rating
- Geographical coordinates for the centre of each glacier unit
- Name of each glacier unit (if available)
- Drainage basin
- Glacier number
- Classification of glacier type and form
- Direction of flow (8 compass points)
- Ablation area surface (if optimum satellite imagery)
- Source of information (cf. Level 1)

L e v e l 4

(satellite imagery plus topographic maps needed)

L e v e l 3 PLUS

- Highest and lowest elevations of glacier with accuracy ratings
- Transient snowline elevation with accuracy rating
- Date of transient snowline observation
- Drainage basin (as detailed as possible)
- Glacier number
- Glacier length with accuracy rating
- Debris-covered surface area with accuracy rating
- Source of information
 - satellite imagery (cf. level 1)
 - map: scale, year of data shown, quality, publication date
- Accessibility

Preliminary glacier inventories as defined by the first two levels can be done quite easily, provided reasonably good satellite imagery is available.

Level 3 demands more effort, and level 4 does not deviate much from a standard glacier inventory as defined in the TTS 'Instructions'.

2.4. Explanations

An example of a data sheet is given on page 8. This data format is not compulsory. If a collaborator prefers his/her own system he/she may use it, provided that he/she explains his/her format when the data are sent to the TTS.

2.4.1. Level 1

Optimum satellite images should be cloud-free scenes taken at the end of the ablation season. The imagery must be described in detail. If possible a black-and-white copy should be sent to the TTS. This applies for all inventory levels.

A reasonable accuracy rating is very important. The following scheme is suggested (from: TTS 'Instructions for Compilation and Assemblage of Data for a World Glacier Inventory') The same scheme is suggested for all the other levels.

Accuracy ratings

index	areal accuracy (%)
1	0 - 5
2	5 - 10
3	10 - 15
4	15 - 25
5	> 25

2.4.2. Level 2

Satellite imagery, accuracy ratings:
same as under level 1.

Geographical coordinates:
same as under level 1.

Geographical coordinates:
as precisely as possible (centre of glacierized areas)

Simple classification:
Suggested abbreviations are MG (Mountain Glacier) or IC (Ice Cap)

2.4.3. Level 3 and Level 4

Level 3 may be difficult to accomplish, unless really excellent satellite imagery is available. An example of a data sheet for glacier inventories at these levels is shown on the following page. This data sheet may be copied. If needed, the TTS can provide additional copies. Nobody is required to fill in all the parameters shown on this data sheet.

Country:

You are recommended to use the abbreviations of motor car plates. If these take more than two digits, correspondents are free to make their own abbreviations.

Continent: 1: South America
 2: North America and Greenland
 3: Africa
 4: Europe
 5: Asia
 6: Australia, New Zealand, New Guinea
 7: Antarctic and Antarctic Islands

Drainage:

The TTS code given in the 1978 Supplement to the 1977 'Instructions' may be used. In order to do so, a hydrological sketch map of the region should be sent to the TTS which will then code the drainage basins.

Glacier Number:

Alphabetical and/or numerical digits may be used.

Classification:

It is suggested that digits 1 and 2 of the classification scheme given in the 1977 'Instructions' should remain in use:

PRELIMINARY GLACIER INVENTORY : Levels 3 and 4

Level	1
Country, Continent	2 4
Drainage	5 16
Glacier number	17 21
Glacier name	22 33
Latitude	34 35 37 41
Longitude	42 43 46 50
Classification	51 52
Direction of glacier flow	53 54
Surface area: total (km ²)	55 60
: accuracy	61
: ablation zone (km ²)	62 67
: accuracy	68
Source of information	69 71
Date of information (day/month/year)	72 77
Total number of punch cards	78 79
Running number of punch card	1 80

Country, Continent	1 3
Drainage	4 15
Glacier number	16 20
Debris cover	25 29
Elevations: highest (m.a.s.l.)	34 37
: accuracy	38
: lowest (m.a.s.l.)	39 42
: accuracy	43
: snow line (m.a.s.l.)	44 47
: accuracy	48
: date of snow line (day/month/year)	49 54
Glacier length (km)	55 63
Accuracy	64
Map: scale (in 1000)	69 72
: year (specify information or publication)	73 74
: quality	75
Accessibility	77 79
Running number of punch card	2 80

Classification of glacier type and form

Index	Digit 1 Primary classification	Digit 2: Form
0	uncertain	uncertain
1	continental ice sheet	compound basins
2	ice-field	compound basin
3	ice-cap	simple basin
4	outlet-glacier	cirque
5	valley-glacier	niche
6	mountain-glacier	crater
7	(glacieret)	ice apron
8	ice shelf	

Direction of flow:

In octants N, NE, E, SE, S, SW, W, NW

Surface area, elevations, lengths:

It is recommended to use the coding system given in TTS, 1970: Instructions for Compilation and Assemblage of Data for a World Glacier Inventory":

Accuracy ratings

index	areas,length (%)	altitudes (m)
1	0 - 5	0 - 25
2	5 - 10	25 - 50
3	10 - 15	50 - 100
4	15 - 25	100 - 200
5	> 25	> 200

Source of Information, type of imagery:

The following indices are suggested. A paper copy of the imagery in question sent to the TTS would be helpful.

Type of imagery

index	Digit 1 Resolution	Digit 2 Type	Digit 3 Quality
1	better than 10 x 10 m	aerial photograph	excellent
2	up to 35 x 35 m	false colour composite sat. imagery	excellent, but with dark cast shadows
3	up to 60 x 60 m	black and white sat. imagery	good, but not taken at the end of ablation season
4	up to 90 x 90 m	RBV sat. imagery	good, but with slight cloud cover
5	worse than 90 x 90 m	other, to be specified in the report	reasonable
6			bad

Map quality:

1:	excellent
2:	good
3:	inaccurate elevations
4:	considerable areal distortions

Accessibility

This aspect of glaciers was neglected in the 1977 TTS 'Instructions' as well as in the 1970 UNESCO/IAHS guidelines. It may become important however, in the context of choosing glaciers for detailed studies or in water resources management. The following classification scheme is proposed:

Accessibility

Index	Digit 1 Accessibility	Digit 2 Use	Digit 3 Dangers
1	easy, by car	meltwater used for irrigation	ice avalanches on settlements possible
2	easy, horseback or on foot	meltwater used for hydropower generation	glacier outburst floods possible, threatening settlements
3	easy, but very time-consuming	summer skiing possible	ice avalanches on uninhabited terrain possible
4	difficult		glacier outburst floods possible, but not threatening human settlements
5	ideal for glacier studies		other dangers

Appendix 1List of Authors for U.S. Geological Survey Paper
Satellite Image Atlas of Glaciers

(by Dr. R.S. Williams, Jr., U.S. Geological Survey, Reston, Va.)

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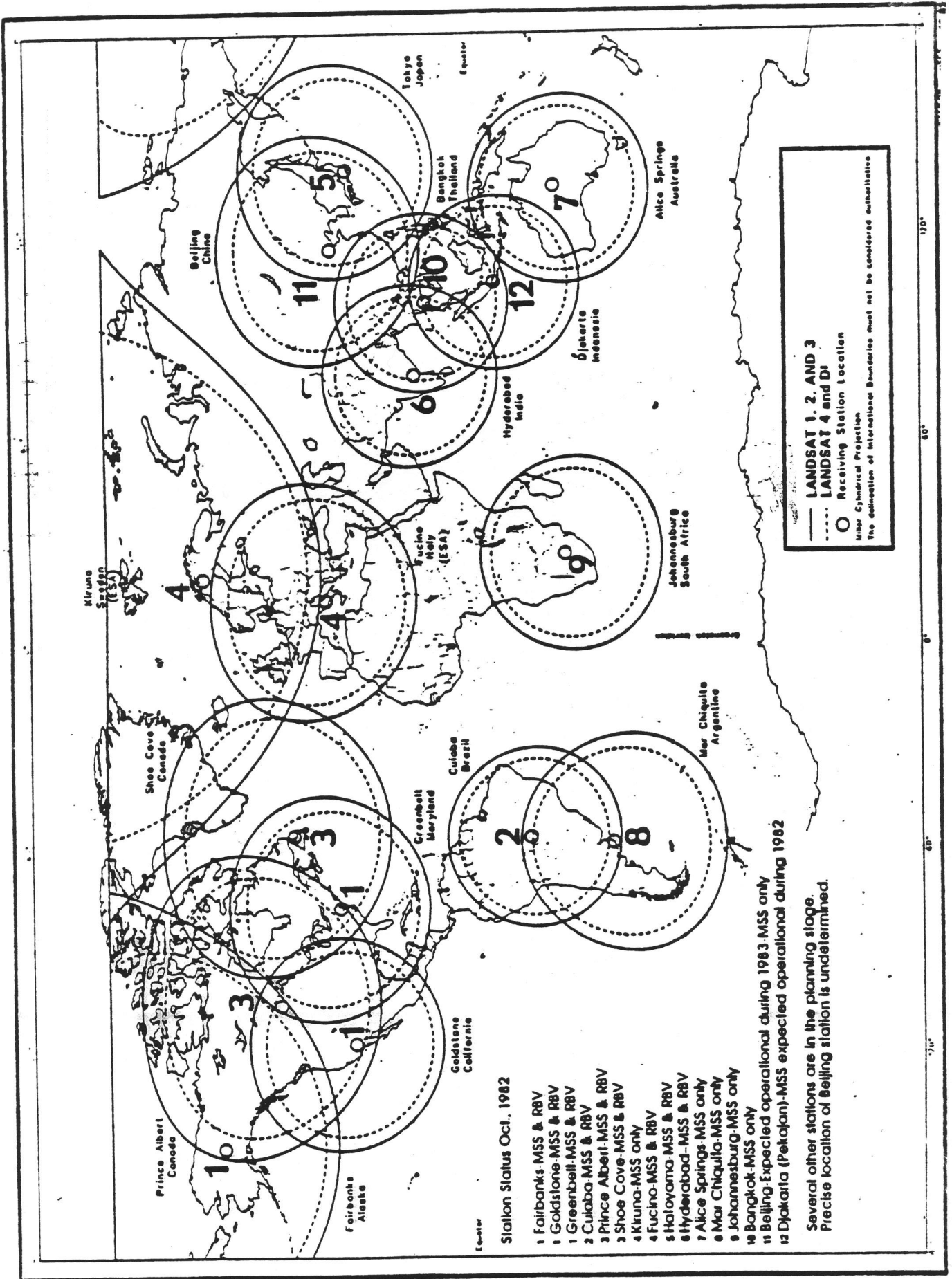
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Appendix 2

Landsat Receiving Station Coverage



Appendix 3

International Landsat Data Distribution Centers

- 1** User Services Section
EROS Data Center
U.S. Geological Survey
St. Louis, MO 63101
Telephone: (605)594-6151
TWX: 910-668-0310
USGS EROS SFL
- 2** Instituto de Pesquisas Espaciais (INPE)
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ATUS-Barco de Imagens Terrestres
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- 3** Canadian Centre for Remote Sensing (CCRS)
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717 Bellair Road
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