Road Weather 30 Years - Hindsight, Insight, Foresight

Auli KESKINEN, PhD
Docent on Futures Research and Political Science
Director, R&D, Ministry of the Environment
PO Box 35, FIN – 00023 Government, Finland
Tel: +35840 5445 283 Fax: +3589 160 39716
Email: auli.keskinen@uta.fi

Abstract

The COST30 project, which formed part of the COST programme of European Co-operation in the Field of Scientific and Technical Research, was set up in 1970 (EUCO-COST30 BIS 1985). The overall objective of the project was to improve traffic safety and flow on major, high-speed roads throughout the promotion of electronic traffic aids for detection of road conditions and for communication with the drivers. The project specifically aimed at the development of functional specifications and standards for the interface between the driver and the system that would ensure compatibility across the national borders. One of the project's themes dealt with road and weather and was chaired by Finland.

Introduction

There is a story on how Finland was engaged in this project. In the 70's Finland was not a member of the European Union, however, many COST projects had Finnish participants since COST activity was open to other countries than the Member States at their own expense. At the beginning of COST 30 preparatory meetings conducted by the COST Transport Committee were held in 1973-1974. Prior to the meeting, where COST 30 plans were on the agenda the Finnish representative of MoTC had an *ad hoc* discussion with the Director of Vaisala Ltd. During the discussion the idea emerged that Finland would benefit from participating in an electronic development project on weather-related issues. In the meeting the Finnish representative explained about weather hazard for traffic and suggested that this problematique should be included, because weather surely is an important factor affecting driving conditions. The meeting listened carefully but did not make any decisions. It then happened that the chair of the Transport Committee stranded in a flood while driving a car in Yugoslavia the following summer, and was henceforth assured of the importance of weather phenomena for traffic. In the next Transport Committee meeting when the Finnish representative raised the issue again, the meeting readily agreed after having heard the chair's story. Then the chair asked if Finland would take the responsibility for the weather and traffic project. This was agreed by the Finnish MoTC, too, and financing was cleared finally by the MoF. The theme 8 'Automatic Detection of Bad Weather' (and later a co-ordinating theme 9) was added to the COST 30 project to be co-ordinated by Finland. The development and results of the Road Weather Research and Systems in Finland is thoroughly presented by Auli Keskinen, the co-founder of SERWEC (Keskinen, 1999).

Hindsight: Road Weather Research and Development

From the Finnish point of view, the ***road weather has now been researched and developed*** for 30 years, since Finland joined COST activities in 1971 and the COST30 project in 1974. The next phase, COST30, in 1977-1980 was executed on the basis of a concerted action covering co-ordinated national research programmes. The third phase COST30 Bis consisted of two parts, an interim phase from April 1980 to April 1982 and final phase from April 1982 to April 1984, subsequently extended to the end of March 1985. (EUCO-COST30 Bis 1985). The COST30/8 activities were also continued as a new COST309 project during the years 1987-1990 (COST309 1992). The overall time schedule for the EUCO-COST projects and the parallel Finnish application projects for Road Weather System and Service are presented in the following table 1 (Keskinen 1999):

Table 1. Time periods and Activities of COST 30 and Road Weather Service Projects

Time Periods	Activities	Actions / Comments
1970	COST30 project started by EU/DGXII.	7 European Union MSs.
1970 - 1977	Preparatory phase for R&D in road traffic.	4 more countries joined.
1971	Finland joined in COST activities.	
1974 - 1976	Basic R&D done for both COST30 and the Finnish application started by the MoTC Steering Committee.	
1977 - 1980	COST30 started (MoU signed), with 9 themes. Theme 8 chaired by Finland.	Each theme chaired by different countries (MSs mostly).
1977	Automatic road weather station (AWS) prototype.	New microprocessor technology
1978 - 1979	First experiments of Road Weather Service.	employed.
1979	Final report of Theme 8.	System running 1979-1981
1980 - 1984	COST30 Bis, continuation phase, Finnish Application.	
1980 - 1982	Interim Phase of COST30 Bis.	
1980 - 1982	Preparation of the Finnish systems development plan and the Finnish application project period.	Special working group of MoTC.
1979 - 1982	Experiments of Road Weather Service.	Experiments in Turku and Helsinki areas,
1982 - 1984	Final Phase of COST30 Bis.	coming of videotex.
1983 - 1985	Routine use of the Finnish Road Weather System.	Enhancement of the system.
1983 - 1984	COST30 Demonstration in the Netherlands.	
1985	Final report of COST30 and COST30 Bis.	Final conference in Paris. SERWEC starts.
1986 - 1987	Development plan of the Finnish system by NBR who takes responsibility of the total system.	FMI & NBR activities re-organised, Networking.
1987 - 1990	COST309 Project.	Finland co-ordinated two subprojects New name 1990: SIRWEC.
1987 - 1992	New Development of Extensive Road Weather Service System.	Upgraded technology.

In the table, FMI is Finnish Meteorological Institute, NBR is National Board of Roads, SERWEC is the Standing European Road Weather Committee, MoTC is the Ministry of Transport and Communications, and MoU is the Memorandum of Understanding.

The COST30 project included 9 themes:

Theme 1: In-car oral communication with the driver,
Theme 2: In-car visual communication with the driver,
Theme 3: Communication with the driver by variable traffic signs or signals,
Theme 4: Radio broadcasting of traffic information,
Theme 5: Information needs from the part of drivers and road authorities, benefits and advantages of communication with drivers,
Theme 6: Automatic or manual detection of incidents affecting traffic,
Theme 7: Clear, correct and unambiguous terms for use in messages in different languages,
Theme 8: Automatic detection of bad weather,
Theme 9: Equipment required for control centres and data transmission, strategies for traffic regulation on motorway networks and proposals for an international demonstration.

The themes were chaired by different countries, Theme 8 by Finland. The project ended with a sizeable demonstration system, which was built on the Dutch motorway network between the Hague and Rotterdam from April 1983 to April 1984. (EUCO-COST30 Bis 1982 and 1984, Keskinen 1982a). The Finnish results of R&D were also at display, including the automatic road weather station with new sensors and a road weather service system. (EUCO-COST30 Bis 1982 and 1984.)

COST30 Theme 8: Road Weather (Automatic Detection of Bad Weather). The Theme 8 was about research and development on automatic detection of bad weather conditions. The aim of the research was to study the interconnection between road traffic and weather and to develop up to a prototype stage an electronic system for detecting and warning for weather and driving conditions and their predictable changes. The system should detect, predict and give warning of hazardous changes in each of the following conditions: visibility, wind speed and gustiness, skid risk due to changes in weather, and flood risk. Furthermore, the aim was to examine the problem of short-term weather forecasting and its repercussions on road maintenance, traffic strategy and the identification of bad weather 'blackspots'. (EUCO-COST30 Theme 8 Working Group 1979.)

The work of theme 8 was largely concerned with the development of a road weather detection system comprising a number of localised road weather monitoring stations. Each station would enable road weather conditions to be automatically detected on a particular section of road. The system could monitor particular blackspots or be extended to cover selected points along a road or even the entire road network. More detailed information than that provided by the existing meteorological services would then become available, and drivers, road maintenance crews, and traffic control authorities might all expect to benefit. By using the information from the weather service and the data automatically observed on the road weather stations it has become possible to predict the surface temperature of the road some hours ahead. All in all, the main aims were to: a) improve traffic safety, b) reduce traffic costs, and c) optimise road maintenance operation and reduce maintenance costs. (EUCO-COST 30 Theme 8 1979.)

Finland joined the COST30 project in 1974 and started to co-ordinate Theme 8 in 1975. Participants in the working group of COST30/Theme 8 were from the National Board of Public Roads and Waterways (NBW) in Finland, Transport & Road Research Laboratory in the UK (TRRL), Bundesanstalt für Strassenwesen in the Federal Republic of Germany, Rijkswaterstaat in the Netherlands, National Swedish Road Administration in Sweden, Ministerialrat im Bundesministerium für Inneres in Austria, Finnish Meteorological Institute in Finland (FMI), Swiss Meteorological Institute in Switzerland, Elin Ltd in Austria, Vaisala Ltd in Finland, State Technical Research Centre in Finland (VTT), Statens väg- och trafikinstitut in Sweden and the EC Commission in Switzerland. (EUCO-COST30 Theme 8 1979.). From the beginning of 1975 the MoTC Steering Committee and the FMI Working Group were set up to conduct R&D on road weather.

Outcome of COST30. The final conference of the EUCO-COST 30 and 30 Bis projects was held at OECD headquarters in Paris in June 1985 (EUCO-COST 1985) (Keskinen 1985b). In this conference the theme 8 was actively participated and supported, and there was the consensus that European co-operation should continue within this theme. At the closing session the chairman made the following statement:

> There is need for R&D work in the field of road weather conditions, in order to improve traffic safety, and to help winter road maintenance. Taking into account the resources needed and the need for harmonisation and standardisation, co-operative research work is highly appreciated. The following are examples of the important research topics: detection and short term forecasting of road and weather conditions. It would be very much appreciated if SERWEC could prepare a proposal for this new research project. (EU Commission 1992, 4.)

Hence the Standing European Road Weather Commission (SERWEC), which was set up by the second international road weather conference held in Copenhagen in February 1985 (Vejdirektoratet 1985), was given the task to draft future R&D co-operation. Already before that, the first international Road Weather Expert Meeting was held in the Hague in conjunction with the demonstration in February 1984 where the R&D co-operation continuation of road weather was first discussed (Thornes 1986).

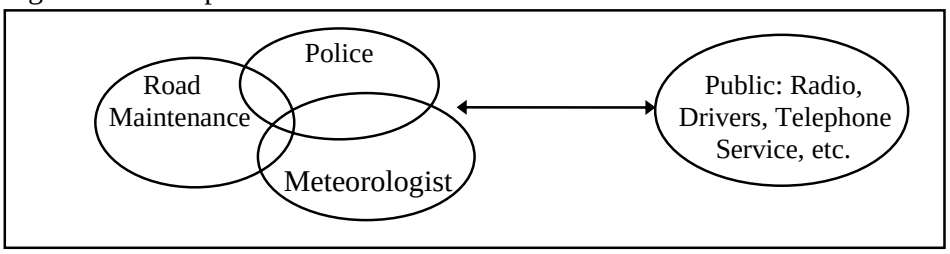
Allen Perry from Swansea University and myself chaired the first Road Weather Expert Meeting in the Hague in 1984 (FMI 1986, Thornes 1986). We were then elected by the participating 50 experts from 13 European countries as the first chairs for the ad hoc co-operation group, given the name ERWEC (Keskinen 1985a). We were elected as chairs of the Executive Committee as well. The Executive Committee had the first meeting in Birmingham in 1984 and prepared the Constitution and future actions for the newly acquired road weather community (Thornes 1985). The next SERWEC (Standing ERWEC) conference, participated by 90 experts from 14 countries, in Copenhagen in 1985 was chaired by me (Vejdirektoratet 1985).

The COST30 project ended in 1985 but needs for further R&D were apparent. The SERWEC co-operation, which started in 1984 is but one manifestation of this. A new COST project was evidently also needed. COST309 on 'Road Weather Condition', was established for the years 1987-1990. The aim of this project was "to improve traffic safety and traffic flow and to reduce road winter maintenance costs and environmental pollution", and it consisted of 12 themes (subprojects) of which Finland co-ordinated two: Weather Radar and Cost-Benefit Analyses of Road Weather Service. (EU Commission 1992, 5-6.). The first book on road weather was published in 1991 bearing the name: 'Highway Meteorology' (Perry & Symons 1991). Later, the SERWEC was enhanced to cover international co-operation, thus becoming SIRWEC.

Insight: Summary of results of COST30

In summary, COST30 was pioneering in a new interdisciplinary field. To succeed, such activity needs: a) basic and applied R&D, b) new relevant knowledge base creation, c) testing and experiments, d) co-operative decision making routine method development, e) joining resources and bringing various actors to the same negotiation table - virtually or physically, and e) studying and developing joint operations on the joint interest area. The interdependence of the actors concerned can be summarised as in the following figure 1 (Keskinen, 1999).

Figure 1. Interdependencies of Road Weather Actors.

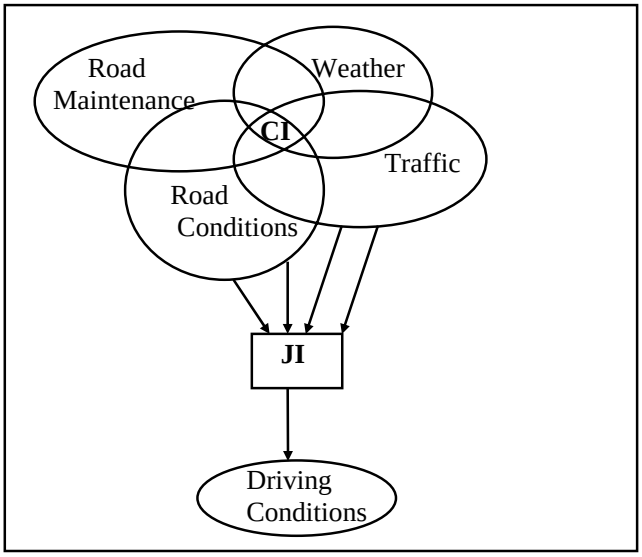


The Finnish application of the results of the COST30/8 work were developed and implemented in the early 80’s, and the system still runs today, with various systems changes and enhancements introduced along the way. A general winwin approach was used in research and development as well as in routine operations and in implementing the systems change.

Some research highlights in Finland. The road weather research concentrated on road condition measurements and forecasting conducted by the Research Co-operation Group (Keskinen et al. 1981, Keskinen 1980b). It was found out early that there was a strong cross-impact between road conditions and traffic and that the joint impact of road maintenance and weather was crucial for the

kind of driving conditions that emerged (MoTC 1982). The cross-impact between road conditions and traffic and the joint impact of road maintenance and weather on driving conditions can be illustrated by applying the framework of cross-impact (CI) & joint impact (JI)), as is presented in the following figure 2 (Keskinen, 1999).

Figure 2. Cross-impacts and Joint Impact of Road Weather.



The automatic road weather station was developed to form a consistent set of hardware and software, see the following figure 3. It now consists of one pole to be erected by the roadside. The attached sensors include those of air and road surface and road layers temperatures, wind, rain amount and intensity. The on-site processor attached to the pole collects the sensor measurements every minute, analyses the road conditions from the data, and sends the data to the local server computer (Pilli-Sihvola 1993).

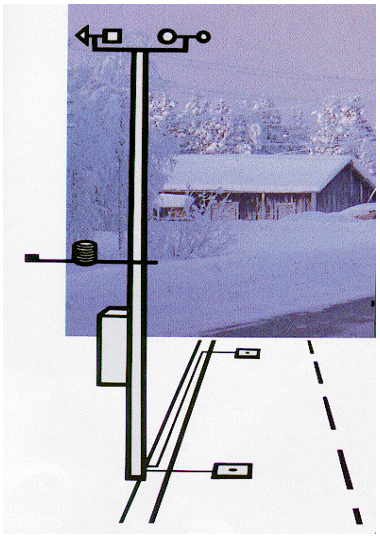


Figure 3. Automatic Road Weather Station 1992.

In the figure, there are several sensors attached, which measure temperature in the air, on the surface of asphalt and inside the road structure. Especially the surface measurement sensor has needed a long development process, since the traffic with studded tyres and the freezing-thawing process of surface wetness often combined with salt, sand, and dirt, causes several types of stress, wear and tear. Wind speed and direction, humidity and amount of rain are also measured. (The figure is from Pilli-Sihvola 1993)

The road weather system has been further advanced after 1992 by a joint research effort with the European Union. The Road Administration is developing new telematics solutions to improve traffic flow, traffic safety and driving comfort. Transport telematics increase the effectiveness of traffic control, traffic information and winter maintenance. This activity is included in the Viking project within the Trans-European Network for Transport (TEN-T) and PROMISE, having here one of the demonstrated test areas, i.e. the highway between Turku-Helsinki-Vaalimaa in 1996-1998.

Summary and Conclusions. The Road Weather Service development in Finland was based on European R&D Co-operation in the field of Transport. The EUCO-COST30 project made basic and applied research and development on electronic aids for major roads. Finland steered the R&D on the impact of weather on road traffic. The major outcomes of the work are: a) new data, information and knowledge was generated concerning the previously *terra incognita* of 'road weather', b) intersectoral decision making practices were developed, c) new ICT was successfully developed and exploited, and d) an international routine co-operation body 'SIRWEC' (earlier SERWEC) was created. (Keskinen 1999).

Foresight: Futures Thinking, Futures Images

Futures research is a new discipline that introduces multidisciplinary approach to multi-stakeholder phenomena such as road weather. Futures research is based on the understanding that human (and in our knowledge society ever more mixed human and technical) systems are open systems that are in continuous interaction with its operational environment, i.e. there is a constant flow of information, energy, material and actors in and out of the system. This means that the future behaviour and "destiny" of such a system cannot be forecast in any meaningful way. Therefore, alternative futures of such systems are heavily dependent on the independent agents working in the system, their actions, decisions and collaboration. The future that emerges is also dependent on the robustness of the system itself - how well it can tolerate change elements from outside of the system and within the system, and how well it can adapt to change. (Checkland 1985, Castells 1996, Kauffman 2000)

Futures research is research on present from a specific futures knowledge point of view. It studies the futures alternatives using what-if analyses, expert Delfoi-surveys, futures workshops, trend and wild card analyses etc. This type of research relies heavily on human interaction and collaboration of diverse expertise and establishing common interest areas. (Bell 1997, Malaska 1991). The basic questions are: when thinking about future, what kind of future is desirable, what is possible, what is probable and what is avoidable. The future that is fulfilled is thus dependent on the joint outcome of future images based on these research results. But no desirable future can be pursued in real life without human will, motivation, competence and access to relevant knowledge.

What possible future changes will affect the future of road weather. We can start with the elements in figure 2 and discuss their alternative possible and desirable futures in the following manner:

Weather and Climate: How will the weather and climate change in the future? These are of course natural systems that are only partly affected by human actions. But how probable it is - as suggested by climatologists and other experts - that climate changes so that winter maintenance is not so very important anymore, as it is dependent on the winter weather?

Road Maintenance: How will road maintenance actions be developed in the future? What is the desirable future like? Is it important to find new more efficient methods? Or should the methods be more environment-friendly? More steerable on the site and even more automatic? Should the de-icing substances be more advanced? This type of interactive research on the needs and wants of society are needed when planning future actions.

Road Surface: What changes do we expect for the road surface itself? Do we want different materials to be used on the road surface that are not slippery and do not react to weather so readily? Then again, is it possible to develop new materials of this kind but that these would be cheaper and more readily available? Or, can we imagine some other innovation to be created for constructing road surface in a quite different manner? What would then be the desirable future?

Vehicle: What are the vehicles like in the future? Do they have rubber tyres or wheels at all, for that matter? What if the cars will be air-borne? Then the slipperiness is quite another matter? What impacts would this have for the road maintenance? What if the tyres are not made of rubber? Do we need or want to innovate new type of interface between the car and the road surface that would not be slippery at all? In this question, so many stakeholders come into play. The most important question here is: What do we actually want?

Traffic: How will the traffic change? Can we guide its changes? Who will have impact on the flow of traffic in general? European Union has many traffic policies so can we see from there whereto the traffic flow is changing? What about new fuels? Will that have an effect on traffic? Traffic modes, what changes are likely and more important, what changes are wanted in the break down of traffic modes? Should be form policies to guide cargo and human traffic to change over more and more to trains and ships? Air traffic is already in crisis, and so is road traffic in many urban areas - maybe we need drastic changes in traffic modes? And who are the prime actors in this policy change? Do we foresee possible horror scenario - a future that we want to avoid at all costs?

Driver: How will the driver change in the future? Do we see the car driving more and more automatically, without much human interaction? And is that desirable? How does this then affect road maintenance operations? Is it likely that automatic cars will result to fewer accidents? Do the people want to drive themselves? If cars get air-borne, perhaps automatic driving is a necessity? This leads us to the question of mobility.

Mobility: Is it not so, that the fact the people and goods travelling constantly around the globe is very unecological and very uneconomical? Is it really necessary to e.g. milk the cows in northern Finland, transfer the milk to Denmark, make yoghurt there and transfer the canned yoghurt back to the neighbouring supermarket nearby the dairy where the milk started its journey? This is a factual situation, but why is it done? In the knowledge society, would it not be much more economic and sustainable development to transfer the recipe of the yoghurt to the yoghurt factory built in the same town as the original dairy? And what effect would this type of development have on road weather services?

References:

Bell, Wendell: *Foundations of Futures Studies. Human Science for a New Era*, Volume I. History, Purposes, and Knowledge. Transaction Publishers, London, 1997

Checkland, Peter: *Systems Thinking, Systems Practice*, John Wiley et Sons, Pitman Press, Bath, Avon, 1985

Castells, Manuel: *The Information Age: Economy, Society and Culture*, Volume I : The Rise of the Network Society, Blackwell, UK, 1996

EUCO-COST30 /Theme 8 Working Group: *The Development of an Automatic System for Observing, Forecasting and Warning of Adverse Road Conditions Due to Bad Weather*, Final Report, Helsinki, Aug. 1979

EUCO-COST30: *Electronics and Traffic on Major Roads. Technical, Reglementary and Ergonomic Aspects*, Proceedings, International Seminar, Paris, 4-6.6.1985

EUCO-COST30 Bis: *The International Public Demonstration on Electronic Traffic Aids on Major Roads*, EU/DGXII, Brussels, 1982

EUCO-COST30 Bis: *Final Report of the Demonstration Project Group. Electronic Traffic Aids on Major Roads*, EU/DGXII, Brussels, 1984

EUCO-COST30 Bis: *Electronic Traffic Aids on Major Roads. COST30 BIS*, Final Report, EU Directorate of General Information Market and Innovation, Luxembourg, 1985

EU Commission: *COST309. Road Weather Conditions*. Final Report for Transport - Research, EUR 13847 EN, Luxembourg, 1992

FMI (Finnish Meteorological Institute): *Third International Road Weather Conference*, Proceedings, Tampere, 24.2.1986

Kauffman, S. A. *Investigations.* Oxford University Press. Oxford, 2000.

Keskinen, Auli & Mäkelä, Martti: *COST Automatic Road Stations (CARS). Operation and Structure*, Draft 1, COST30/8 Publishing, Helsinki, June 1977

Keskinen, Auli & Nysten, Erkki: *Some Aspects of the Dependence between Friction and Weather Parameters on Roads and Runways*, Technical Report No. 13, FMI, Helsinki, Feb. 1977

Keskinen, Auli: *COST Automatic Road Station - Structure and Operation* in Proceedings for 11:e Nordiska Meteorologmötet, Norrköping, 29.5-2.6.1978

Keskinen, Auli: *Operation and Use of the COST30 Automatic Road Station (CARS)*, Technical Report No. 21, FMI, Helsinki, 1979

Keskinen, Auli: *Detection and Forecasting of Slipperiness for Road Winter Maintenance in Finland within EUCO-COST30 Project*, in Proceedings for 12:e Nordiska Meteorologmötet, Hanaholmen, Finland, 27-30.5.1980a

Keskinen, Auli: *Detection and Forecasting of Slipperiness for Road Winter Maintenance in Finland within EUCO-COST30 Project*, in Proceedings for WMO Symposium on Probabilistic and Statistical Methods in Weather Forecasting, Nice, 8-12.9.1980b

Keskinen, Auli: *Costs and Benefits of Weather Service for Road Winter Maintenance in Finland*, EUCO-COST30/8, FMI, Jan. 1980c

Keskinen, Auli: *Road Weather Experiment in the Helsinki Area*, in Proceedings for the 13 Nordiske Meteorologmöde, Copenhagen, 7-11.6.1982a

Keskinen, Auli: *A Viewdata Based Weather Service System for Road Maintenance and Traffic*, in Proceedings of International Conference on Road Traffic Signalling, Institution of Electrical Engineers (IEE), Conference Publication No. 207, London, 30.3-1.4.1982b

Keskinen, Auli: *Economic Benefits of Weather Forecasting in Finland*, Finnish contribution of FMI for ECMWF Technical Memorandum No. 81, ECMWF, Reading, Nov. 1983

Keskinen, Auli: *Videotex and Weather Services - Finnish Applications*, in Proceedings of WMO Nowcasting II Symposium, Norrköping, 3-7.9.1984

Keskinen, Auli: *Videotex and Weather Services - Finnish Applications*, in Proceedings of Second International Road Weather Conference, Copenhagen, 27.2-1.3.1985a

Keskinen, Auli: *Advancements in Road Weather Development*, in Proceedings of Final International Conference on Electronic and Traffic on Major Roads, EUCO-COST, OECD, Paris 4.6-6.6.1985b

Keskinen, Auli: *Towards User Empowerment. On Development of Utilisation of Information and Communications Technology in Decision Making of Administrations*, Studia Politica Tamperensis, No. 6, University of Tampere, Finland, 1999, http://www.tukkk.fi/tutu/FUTU/KeskinenAuli.pdf

Keskinen, Auli & Lindeman, Tuomo: *Pääkaupunkiseudun tiesääpalvelukokeilu HKI1*, in Finnish, (Road Weather Experiment I in Helsinki Capital Area, in 1980-1981), FMI, Helsinki, 1981

Keskinen, Auli & Mäkelä, Martti & Nysten, Erkki & Pilli-Sihvola, Yrjö & Sågbom, Marianne: *Huonon sään automaattiset toteamisjärjestelmät. Tehostettu tiesäähavaintojakso, Kevättalvi 1979*, in Finnish, (Automatic Systems for Observing Adverse Road Conditions Due to Bad Weather, Intensified Observation Period, during the winter of 1978 - 1979), EUCO-COST30/8-report, FMI, Helsinki, 1981

Laszlo, Ervin: "Technology and Social Change: An Approach from Non-equilibrium Systems Theory", in *Technological Forecasting and Social Change* 29, pp. 271-283, Elsevier Science Publishing, 1986

Malaska, Pentti: "Economic and Social Evolution: The Transformational Dynamics Approach", in Laszlo, E (Ed.): *The New Evolutionary Paradigm*. The World Futures General Studies, Vol. 2, London: Gordon & Breach, 1991

MoTC (Ministry of Transport and Communications) & Steering Committee of Road Service Development: *Road Weather Service Development. Final Report*, Steering Committee of Road Weather Service Development & MoTC, MoTC & TVH 722329 (NBR), Helsinki, 1982

Perry, A. H & Symons L. J (eds.): *Highway Meteorology*, E & FN Spon, London, 1991

Pilli-Sihvola, Yrjö: *Tiesääjärjestelmän rakentaminen 1987-1992*, in Finnish, (Building of the Road Weather System during 1987-1992), NBR, Kouvola Road District, 1993

Thornes, John: *Highways Meteorology. The Newsletter of the Standing European Road Weather Commission*, No. 1, Birmingham, Feb. 1985

Thornes, John: *Highways Meteorology. The Newsletter of the Standing European Road Weather Commission*, No. 2, Birmingham, Jan. 1986

Vejdirektoratet: *Second International Road Weather Conference*, Proceedings, 27.2-1.3.1985, Copenhagen, 1985