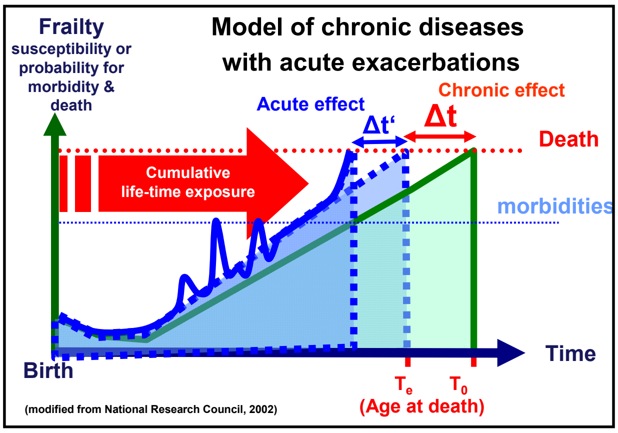
Chronic pulmonary effects of ambient nano-PM:
Lessons learned from PM

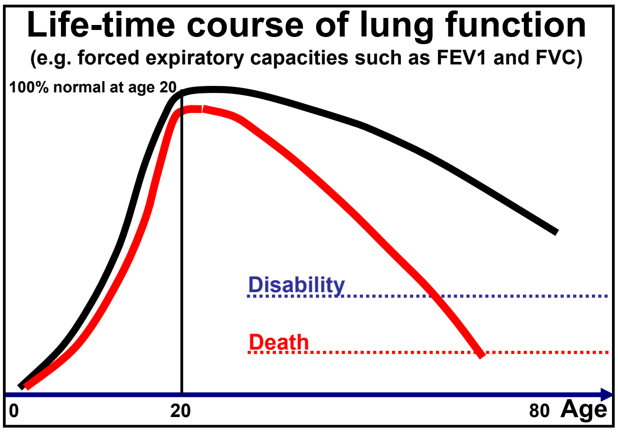
Nino Künzli, MD PhD

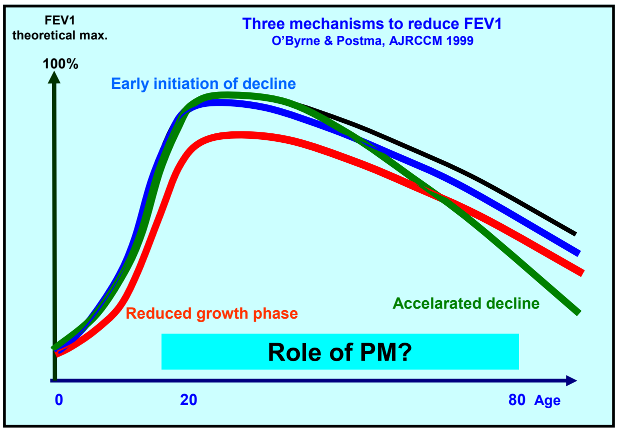
As of May 1st 2009:
Chair of Public Health, University of Basel Medical School
Institute for Social and Preventive Medicine
at Swiss Tropical Institute Basel, Switzerland

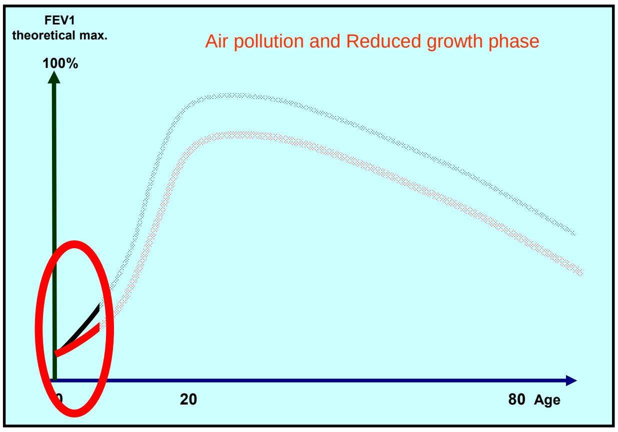
Jan 2006- April 2009: ICREA Research Professor, at Centre for Research in Environmental Epidemiology – CREAL Barcelona - Spain

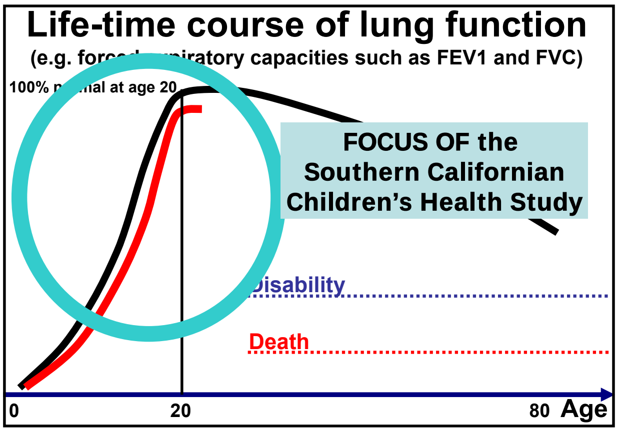
Prepared for 13th ETH Conference on Combustion Generated PM – 23.6.2009 8:30h, Zurich

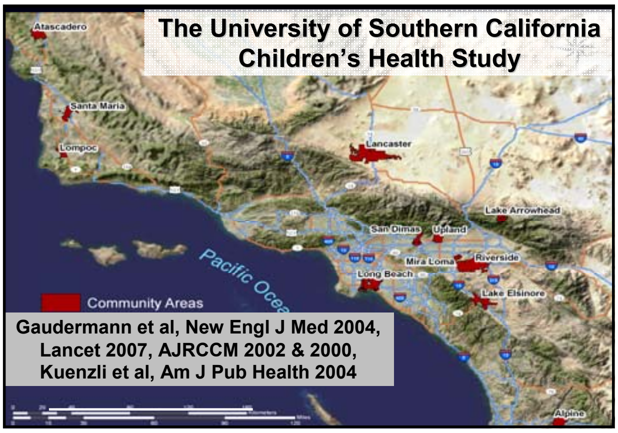


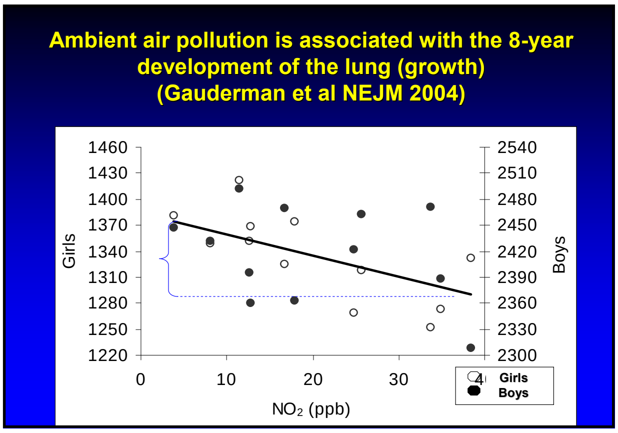


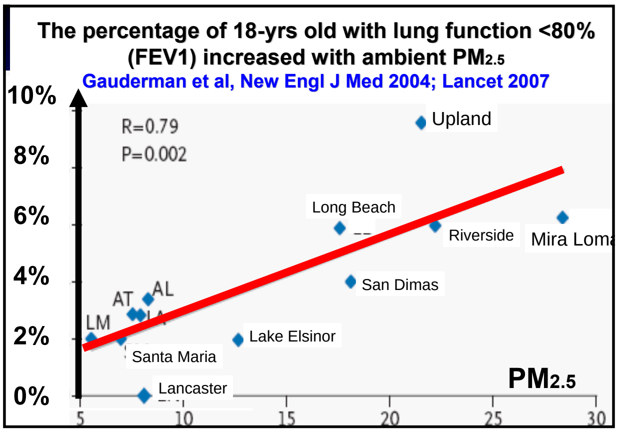


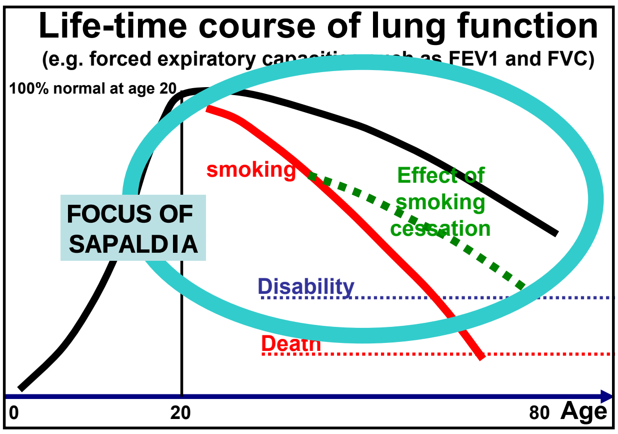












Swiss Study on Air Pollution and Lung Diseases in Adults SAPALDIA Cohort Design

SAPALDIA 1
1991/2

- Address
- Interview
- Forced expiratory lung function
- …

NO2, SO2, TSP, PM10,Meteo

Address Updates 95/97/99

SAPALDIA 2
2001/2

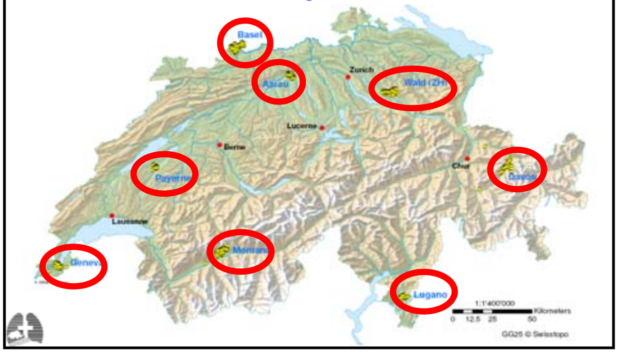
- Address
- Interview
- Forced expiratory lung function
- …

NO2, SO2, PM2.5, PM10, Meteo

- Identical protocols
- Same devices
- Comparison test across devices 1991 and 2001

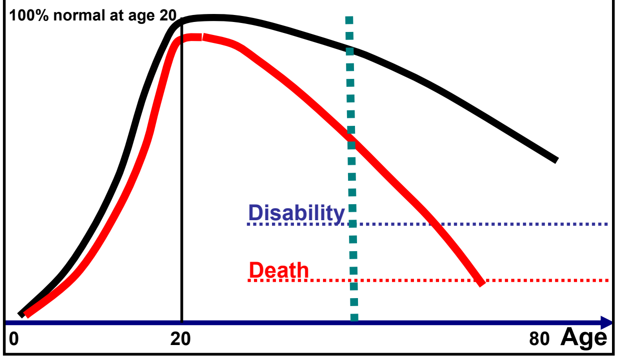
Künzli et al, ERJ 1995; 8:371
Künzli et al, Swiss Med Weekly 2005; 135:503

SAPALDIA 1: 1991-1992 (n=9,651)
Random population samples from 8 Swiss areas
Age 18-60

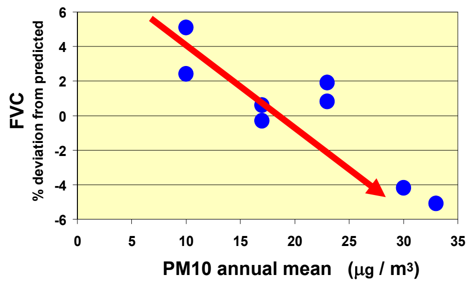


Life-time course of lung function

(e.g. forced expiratory capacities such as FEV1 and FVC)



Annual mean PM10 and expiratory capacity (FVC) in the 8 SAPALDIA areas
Ackermann-Liebrich et al, AJRCCM 1997; 155 (1):122-129

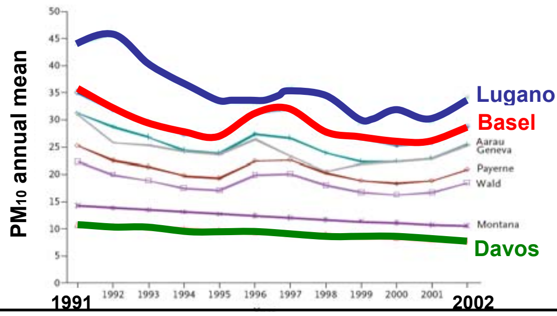


Important changes between baseline (1990/91) and follow-up (2001/2)

1. Air quality improved
2. Advancement of exposure assessment science
3. Many subjects changed residence

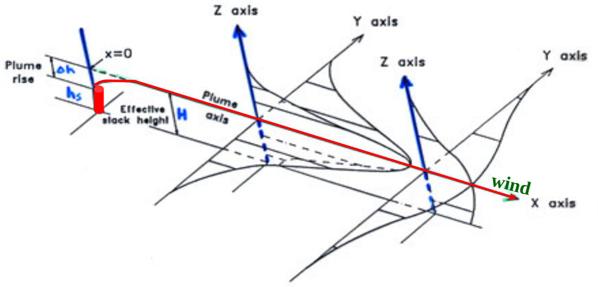
Succes of Clean Air Regulations: PM_{10} concentrations 1991 - 2002

Downs et al.(SAPALDIA Team) , NEJM, 2007



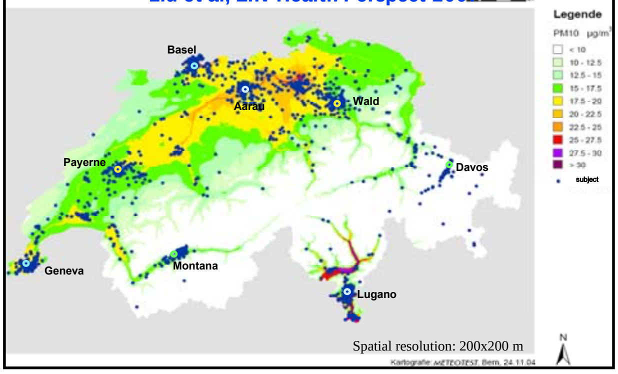
Gaussian plume dispersion models, using emission registries, meteorology, and secondary processes to model the pollution space for Switzerland

Liu et al, Env Health Perspect 2007



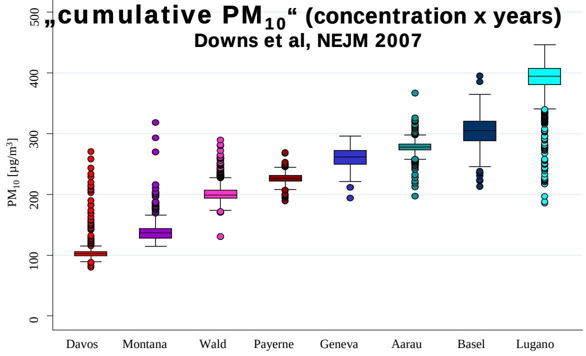
Dispersion model predictions for PM_{10}

Liu et al, Env Health Perspect 2007



Distribution of individually assigned „cumulative PM_{10}“ (concentration x years)

Downs et al, NEJM 2007



The NEW ENGLAND JOURNAL *of* MEDICINE

ORIGINAL ARTICLE

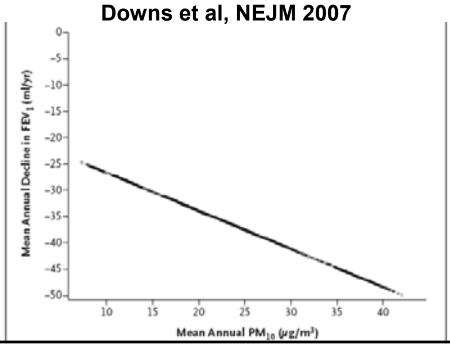
Reduced Exposure to PM_{10} and Attenuated Age-Related Decline in Lung Function

Sara H. Downs, Ph.D., Christian Schindler, Ph.D., L.-J. Sally Liu, Sc.D., Dirk Keidel, M.A., Lucy Bayer-Oglesby, Ph.D., Martin H. Brutsche, M.D., Ph.D., Margaret W. Gerbase, M.D., Ph.D., Roland Keller, M.D., Nino Künzli, M.D., Ph.D., Philippe Leuenberger, M.D., Nicole M. Probst-Hensch, Ph.D., Jean-Marie Tschopp, M.D., Jean-Pierre Zellweger, M.D., Thierry Rochat, M.D., Joel Schwartz, Ph.D., Ursula Ackermann-Liebrich, M.D., M.Sc., and the SAPALDIA Team*

N Engl J Med 2007;357:2338-47.

Estimated effect of interval exposure (1991-2002) on decline of FEV1

Downs et al, NEJM 2007



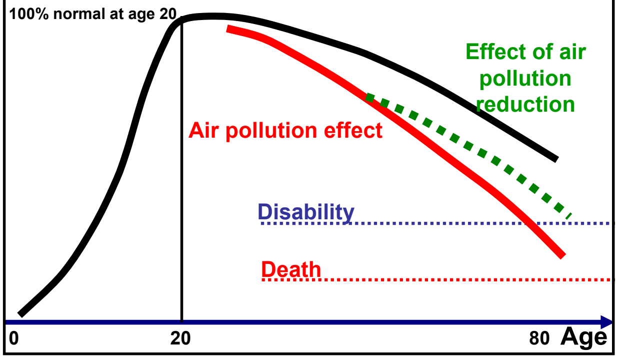
Attenuation of lung function decline per 10 ug/m3 reduction in home outdoor PM10 among 2’213 SAPALDIA never smokers

Downs et al, NEJM 2007

	effect	p-value
–FVC	2.2 ml	0.43
–FEV1	4.2 ml	0.06
–FEV1 in %FVC	0.05%	0.18
–FEF25-75	11.3 ml/s	0.03

Life-time course of lung function

(e.g. forced expiratory capacities such as FEV1 and FVC)



SWISS MED WKLY 2008;138(27–28):387–391 · www.smw.ch 387

Translocation and cellular entering mechanisms of nanoparticles in the respiratory tract

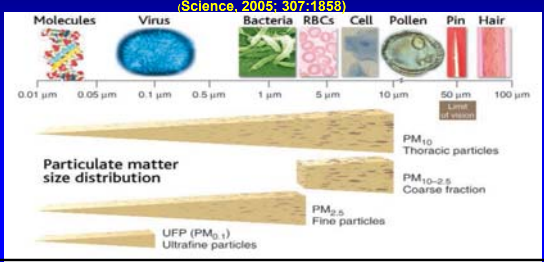
Christian Mühlfeld, Peter Gehr, Barbara Rothen-Rutishauser
Institute of Anatomy, University of Bern, Bern, Switzerland

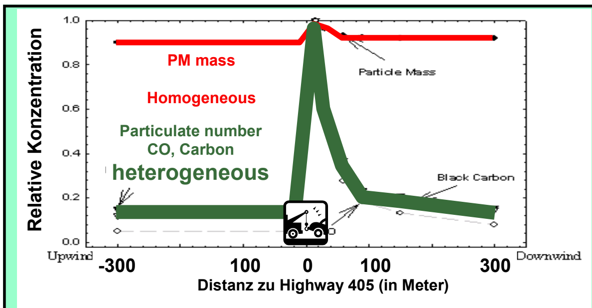
Ambient air pollution: complex mixture of 100's of pollutants

Gases: NOx, SOx, Ozone, CO etc.

Particles: various sizes and constituencies

(Science, 2005; 307:1858)



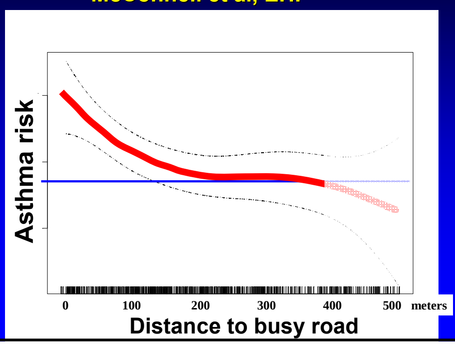


Zhu et al, J Air Waste Manage Assoc, 2002; 52: 1032

From the Southern California Particle Centre

Living close to busy roads is associated with higher asthma prevalence in children

McConnell et al, EHP

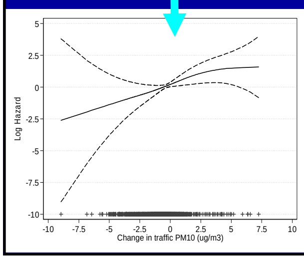


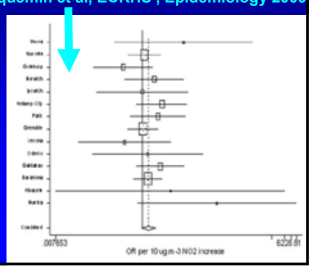
Association between traffic-related pollution and new-onset of asthma in adults: evidence from 2009

Modig et al – RHINE Study, ERJ 2009 – on line

Kuenzli et al, SAPALDIA Study, Thorax 2009 (May)

Jacquemin et al, ECRHS , Epidemiology 2009





Research needs summary

- Investigate specific contribution of nano-PM versus other size fractions
- Investigate spatial distribution of nano-PM and its constituents, to be linked to cohort studies
- Understand link between acute respiratory events, early life time exposure, and chronic development of lung pathologies (SAPALDIA 3)
- Understand exogenous and endogenous susceptibility factors (SAPALDIA 3)

SUMMARY

- Ambient air pollution affects lung development in the long term
- Particulate matter play a causal role
- Specific contribution of nano-PM ?
- Specific contribution of PM sources?

E S C A P E

European **S**tudy of **C**ohorts for **A**ir **P**ollution **E**ffects
(consortium PI: Bert Brunekreef, IRAS)
www.escapeproject.eu

25 European partners, 17 countries,
32 existing cohort studies,
>50 cities and regions

WP 4: RESPIRATORY COHORTS (Adults)
PI: Nino Kuenzli

COHORT	ESCAPE-related PI	PI of COHORT
European ECRHS	Jordi Sunyer	Peter Burney
Swiss SAPALDIA	Nicole Probst-Hensch	Thierry Rochat
German SALIA	Ursula Krämer	Ursula Krämer
UK1946 Birth Cohort	Anna Hansell	Diana Kuh
French EGEA	Francine Kauffmann	Francine Kauffmann
French E3N (EPIC - F)	Isabelle Romieu	Francoise Clavel-Chaplon

Thank you

Nino.Kuenzli@unibas.ch

Professor of Public Health University of Basel

Institute of Social and Preventive Medicine at Swiss Tropical Institute Basel

Int. J. Epidemiol. Advance Access published July 1, 2008

Published by Oxford University Press on behalf of the International Epidemiological Association

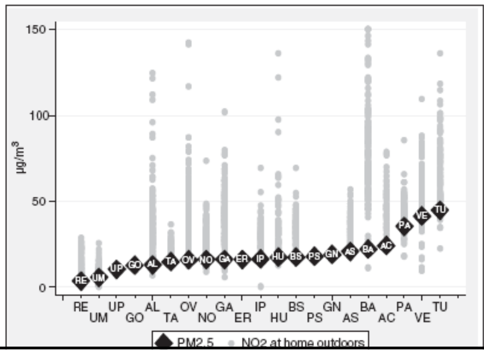
International Journal of Epidemiology 2008;1–10
doi:10.1093/ije/dyn136

Air pollution and lung function in the European Community Respiratory Health Survey

Thomas Götschi,[1] Jordi Sunyer,[2,3,4] Susan Chinn,[5] Roberto de Marco,[6] Bertil Forsberg,[7] James W Gauderman,[1] Raquel Garcia-Esteban,[2,4] Joachim Heinrich,[8] Bénédicte Jacquemin,[2,4] Deborah Jarvis,[5] Michela Ponzio,[9] Simona Villani[9] and Nino Künzli[1,2,4,10]*

The inability to refuse the null hypothesis may reflect (i) no effect of urban air pollution on lung function or (ii) inherent biases due to the study design. Examples of the latter are lack of individual-level air quality assignment, not quantified within-city contrasts in traffic-related pollution, or the heterogeneity of the studied populations and their urban environments.

Within-city constrasts in air pollutants are larger than constrasts between cities



formation of PM2.5 largely differ across Europe

Nawrot et al, Atmos Environ June 2009

Table 3: Summary of independent and significantly correlated covariates of [illegible] formation

City	S	Si	Al	Fe	Zn	Pb	Cu	Ti	As	Mn	V	Na	Cl
Albacete, Spain													-
Antwerp City, Belgium				+		+					+		
Antwerp South, Belgium	+		-		+			+	+				+
Barcelona, Spain											+	-	
Basel, Switzerland				+	+							+	
Erfurt, Germany							+					-	-
Galdakao, Spain							+				+		+
Gothenburg, Sweden		+											
Grenoble, France					+								-
Huelva, Spain					+								-
Ipswich, UK						+							-
Norwich, UK			-		+	-				+	+	-	
Oviedo, Spain	+									+		-	
Paris, France										+		-	-
Pavia, Italy	-			+	+								
Reykjavik, Iceland	+			+									-
Tartu, Estonia				+				-					-
Turin, Italy				+	-	+	+		+				
Umea, Sweden				+							-		-
Uppsala, Sweden			[illegible]					[illegible]				[illegible]	