Contents

Contributors *xiii*

1. Traffic-related air pollution: Emissions, human exposures, and health: An introduction **1**

Haneen Khreis, Mark J. Nieuwenhuijsen, Josias Zietsman, and Tara Ramani

Introduction 2
Acknowledgments 15
References 15

2. Air pollution, air quality, vehicle emissions, and environmental regulations **23**

Wen-Whai Li

Sources of air pollution 25
Pollutant concentration and units 26
History of air pollution control regulations in the United States 28
Pollutant emission trends in the United States 32
Transportation emissions in the United States 36
Transportation emissions and near-road communities 44
Conclusion 46
References 47

3. Traffic monitoring and modeling for energy, air quality, and health **51**

Yanzhi Ann Xu

Introduction 51
Traffic monitoring data 52
Modeling advances 60
Gaps and opportunities 64
Conclusions 69
References 70

4. Vehicle emissions measurement and modeling **75**

Karl Ropkins, Sergio Ibarra-Espinosa, and Yoann Bernard

Introduction 76
Vehicle emissions monitoring 77

Vehicle emissions modeling 90
Current and future challenges 97
Summary and conclusions 103
Acknowledgments 104
References 104

5. Air pollution monitoring and modeling 111
Mohammad Hashem Askariyeh, Haneen Khreis, and Suriya Vallamsundar

Monitoring 111
Modeling 119
Model to monitor comparisons 126
Summary and conclusion 128
References 129

6. Traffic-related air pollution and exposure assessment 137
Sean D. Beevers and Martin L. Williams

Introduction 138
Exposure pathways 141
Vehicle emissions 142
Traffic-related air pollution 144
Exposure assessment methods 151
Conclusions 158
References 159

7. Air pollution epidemiology 163
Zorana Jovanovic Andersen

Introduction 164
Short history of air pollution epidemiology 165
Epidemiological designs for studying short-term health effects of air pollution 168
Epidemiological designs for studying long-term health effects of air pollution 171
Experimental designs in air pollution epidemiology 177
Summary 178
References 179

8. Systematic reviews and metaanalyses of air pollution epidemiological studies 183
Juleen Lam, Hanna M. Vesterinen, and Tracey J. Woodruff

Introduction 183
Systematic reviews and air pollution 185

Traffic-related air pollution systematic reviews 189
Implications for policy- and decision-making 200
Summary and conclusions 201
References 202

9. Established and emerging effects of traffic-related air pollution 207
Mary Fox, Kirsten Koehler, and Natalie Johnson

Introduction 208
Health effects of TRAP: Well-established effects 208
Emerging health effects of TRAP 212
Health effects of TRAP: Special topics 217
Summary and conclusions 220
Suggested readings 221
References 221

10 Evidence from toxicological and mechanistic studies 229
Mark R. Miller and Jennifer B. Raftis

Background 230
Direct actions of vehicle exhaust emissions in biological systems 233
TRAP and the lung 236
TRAP and the cardiovascular system 238
The lung to the peripheral organs 251
The systemic effects of TRAP 254
Conclusions, considerations, and implications 257
Acknowledgments 260
Conflicts of interest 261
References 261

11. Biomarkers and omics of health effects associated with traffic-related air pollution 281
Christiana Demetriou and Paolo Vineis

The exposome and environmental pollutants 282
Previous evidence on biomarkers and air pollution: The example of carcinogenesis 283
The exposome approach 285
Summary and conclusions 303
Acknowledgment 304
Conflict of interest 304
References 304

12. Qualitative health impact assessment **311**
Jennifer S. Mindell and Martin Birley

Introduction 311
What is health impact assessment? 312
Brief history of HIA 312
Determinants of health 315
The HIA procedure 316
Strengths and limitations of HIAs and their use in decision-making 325
Differential health impacts of traffic-related air pollution in sensitive subpopulations 327
Examples of HIAs of road transport 327
Further developments 330
Summary and conclusions 332
Further information 333
References 333

13. Quantitative health impact and burden of disease assessment of traffic-related air pollution **339**
Natalie Mueller, Mark J. Nieuwenhuijsen, and David Rojas-Rueda

Introduction 339
Health impact assessment of transport policies and traffic-related air pollution 340
Qualitative versus quantitative health impact assessment 342
Comparative risk assessment framework 342
Burden of disease assessment 345
Examples of quantitative HIA studies assessing traffic-related air pollution impacts 347
Uncertainty in quantitative health impact assessment 349
Utility of quantitative health impact assessment 352
Further considerations 354
Conclusions 356
References 357

14. Impacts of traffic-related air pollution on policy- and decision-making **361**
Michael O. Rodgers and April Willis Rodgers

Introduction—Pollution in the city 361
Traffic-related air pollution 363
Policy- and decision-making 364

Air pollution in a historical context 365
Air pollution, human health, and public policy 367
The clean air act and environmental regulation 370
Human health and mobile source emissions controls in the United States 371
Traffic-related air pollution and human health worldwide 377
Conclusions 378
References 379
Further reading 381

15. Policy option generation and selection 383
Anthony D. May

Introduction 383
The challenge of option generation 384
The context for option generation 386
The choice of strategy 387
The available policy measures 389
The contribution of different policy measures 392
The development of packages 393
Understanding the constraints on implementing specific measures 393
Approaches to option generation 395
Designing specific projects 398
The approach to option appraisal 400
Conclusions 402
References 403

16. Best practices for air quality and active transportation 405
Andrew Glazener and Haneen Khreis

Introduction 405
Best practices for active transportation and clean air 408
Conclusions 424
References 428

17. Air pollution mitigation through vegetation barriers and green space 437
Richard Baldauf

Introduction 437
Benefits of urban green space 438
Vegetation effects on air quality 439

Vegetation characteristics impacts on local air quality 441
Additional considerations 447
Vegetation collocated with sound walls 448
Applications on urban commercial and residential streets 449
Summary and conclusions 450
Disclaimer 451
References 451
Further reading 453

18. Cost-effectiveness of projects and policies 455
Mark Burris

Introduction 455
The need to quantify the value of clean air 455
Cost-effectiveness methodologies 458
How to quantify costs (impacts) and benefits 460
SFpark—An example of quantifying impacts 466
Summary and conclusions 469
References 470

19. The social, environmental, health, and economic impacts of low carbon transport policy: A review of the evidence 471
Andrew Sudmant, Ersilia Verlinghieri, Haneen Khreis, and Andrew Gouldson

Introduction 471
Land use measures 474
Mode shift and public transport investments 478
Fleet efficiency improvement and electrification 481
Barriers and facilitators to LCUTP implementation 484
Summary and conclusions 487
References 488

20. Environmental justice 495
Christina H. Fuller and Doug Brugge

Definition and historical context of environmental justice 495
The national legacy of the transportation system in urban areas 498
Near-roadway air pollution gradients 499
Exposures and health disparities 501
Contradictory examples 504

Strategies to mitigate disproportionate exposures and health outcomes 505
Summary and conclusions 507
Resources 507
References 508

21. Emerging transportation technologies and implications for traffic-related emissions, air pollution exposure, and health 511

Shams Tanvir, Peng Hao, and Kanok Boriboonsomsin

Introduction 512
Emerging transportation technologies 513
Adoption and adaptation 516
Implications 518
Implementation considerations 524
Conclusions 526
References 527

22. Traffic-related air pollution, human exposure, and commercially available market solutions: Perspectives from the developing nation context 531

S.M. Shiva Nagendra, Uwe Schlink, V. Dheeraj Alshetty, M. Diya, and Jyothi S. Menon

Introduction 531
Urban air quality and health impacts 532
Personal exposure and health risk 533
Control solutions to address traffic-related pollution 534
Summary 538
References 539

23. The state of the literature on traffic-related emissions, air pollution, human exposures, and health 541

Kristen A. Sanchez, Tara Ramani, Josias Zietsman, Mark J. Nieuwenhuijsen, and Haneen Khreis

Introduction 541
Literature library development 544
Literature library features 549
Literature library analysis 552
Library limitations 556
Literature library benefits 557

Future research recommendations 558
Summary 559
Acknowledgements 559
References 560

24. How emerging technology and its integrations is advancing our understanding of urban and traffic-related air pollution 563

John Medeiros and Haneen Khreis

Introduction 564
Methods 566
Results: Emerging measurement methods 567
Discussion and conclusion 581
References 594

25. Traffic-related air pollution: Emissions, human exposures, and health—The way forward 597

Haneen Khreis, Mark J. Nieuwenhuijsen, Josias Zietsman, and Tara Ramani

Introduction 597
Where are we now? 598
Where do we want to go and how will we get there? 608
Summary and conclusions 615
Acknowledgments 616
References 616

Index *621*