Forest management optimization

- *considering biodiversity, global warming and economics goals*

Workshop at: Gorgan University of Agricultural Sciences and Natural Resources (GUASNR), November 2017

Part 1: Optimal adaptive rotation forestry under risk *Version 17-11-06*

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Preparations before the workshop starts:

Lecture room preparations:

It is important that the lecture room has PC projector and necessary cables, screen etc.

It is also important that the lecture room has WiFi connection to the internet.

It is also important that the lecture room has a large whiteboard (at least 3 meters wide and one meter high) and pens with different colors. A large ruler (one meter length) makes the graphs and drawings better.

Preparations before the workshop starts:

Individual preparations:

Preparations to be made before the excercises:

During the excercices, we will use QB64.
It is important that the participants have access to laptops where QB64 has already been installed.
This software can be downloaded for free from this link: http://www.qb64.net/
It is also good if the participants have already installed Lingo.
Here is the link: http://www.lindo.com/index.php/products/lingo-and-optimization-modeling .
During the excecises, it is sufficient to have a simple version, which is free, of Lingo installed. Of course, for more advanced problems, a more advanced version is better. Advanced versions of Lingo can however be very expensive.

In the end of this document, you find the ”Workshop references”.
These references contain central theories and methods that will be discussed and used in the sessions. In the schedule, you find the references that are connected to the different sessions. All references may be downloaded from the internet. Please download the references as soon as possible and store them in your computer since internet disturbances may occur some days.

Workshop references of particular relevance to this presentation:

2,4,9,10,11,21,28

VERY GENERAL INTRODUCTION TO OPTIMIZATION AND OPERATIONS RESEARCH:

[21] Lohmander, P., **Applications and mathematical modeling in operations research, KEYNOTE**, International Conference on Mathematics and Decision Science, International Center of Optimization and Decision Making & Guangzhou University, Guangzhou, China, September 12-15, 2016
http://www.Lohmander.com/PL_KEYNOTE_MATH_2016.jpg
http://www.Lohmander.com/PL_ICODM_2016_KEY.pptx
http://www.Lohmander.com/PL_ICODM_2016_KEY.pdf
http://www.Lohmander.com/PL_ICODM_2016_KEY_PAPER.pdf
http://www.Lohmander.com/PL_ICODM_2016_KEY_PAPER.docx
http://icodm2020.com/en/

[28] Lohmander, P., **Applications and Mathematical Modeling in Operations Research**, In: Cao BY. (ed) Fuzzy Information and Engineering and Decision. IWDS 2016. Advances in Intelligent Systems and Computing, vol 646. Springer, Cham, 2018,

Print ISBN 978-3-319-66513-9, Online ISBN 978-3-319-66514-6, eBook Package: Engineering, LAMMOR, https://doi.org/10.1007/978-3-319-66514-6_5

BACKGROUND AND THEORY OF

Optimal adaptive rotation forestry under risk :

[2] Lohmander, P., **Pulse extraction under risk and a numerical forestry application**, IIASA, International Institute for Applied Systems Analysis, Systems and Decisions Sciences, WP-87-49, June 1987
http://www.iiasa.ac.at/Admin/PUB/Documents/WP-87-049.pdf
http://www.lohmander.com/WP-87-049.pdf

[4] Lohmander, P., **Pulse extraction under risk and a numerical forestry application**, SYSTEMS ANALYSIS - MODELLING - SIMULATION, Vol. 5, No. 4, 339-354, 1988
http://www.Lohmander.com/PL_SAMS_5_4_1988.pdf

[9] Lohmander, P., **Optimal sequential forestry decisions under risk**, ANNALS OF OPERATIONS RESEARCH, Vol. 95, pp. 217-228, 2000
http://www.Lohmander.com/PL_AOR_95_2000.pdf

[10] Lohmander, P., **Adaptive Optimization of Forest Management in a Stochastic World**, in Weintraub A. et al (Editors), Handbook of Operations Research in Natural Resources, Springer, Springer Science, International Series in Operations Research and Management Science, New York, USA, pp 525-544, 2007
http://www.amazon.ca/gp/reader/0387718141/ref=sib_dp_pt/701-0734992-1741115#reader-link
http://www.Lohmander.com/PL_Handbook2007.pdf

[11] Mohammadi, L.S., Lohmander, P., **Stumpage Prices in the Iranian Caspian Forests**, Asian Journal of Plant Sciences, 6 (7): 1027-1036, 2007, ISSN 1682-3974, 2007 Asian Network for Scientific Information, http://ansijournals.com/ajps/2007/1027-1036.pdf
http://www.Lohmander.com/MoLo2007.pdf

Case

The following model (in QB64) solves the Optimal adaptive rotation forestry under risk problem.

We will investigate this model in every detail and learn to understand how to use QB64.

Later, we will marginally modify the model and investigate how the optimal results change.

```
REM
REM STDP_ex1
REM Peter Lohmander 171015
CLS

OPEN "PLEX1.txt" FOR OUTPUT AS #1

PRINT ""
PRINT " Harvest optimization via stochastic dynamic programming"
PRINT " Peter Lohmander Example 1 2017-10-15"
PRINT ""

PRINT #1, ""
PRINT #1, " Harvest optimization via stochastic dynamic programming"
PRINT #1, " Peter Lohmander Example 1 2017-10-15"
PRINT #1, ""
```

```
DIM f(100, 10), u(100, 10), DPProb(10)

REM Delta Price Probability distribution
DPProb(0) = .00
DPProb(1) = .03
DPProb(2) = .07
DPProb(3) = .10
DPProb(4) = .18
DPProb(5) = .24
DPProb(6) = .18
DPProb(7) = .10
DPProb(8) = .07
DPProb(9) = .03
DPProb(10) = .00
```

tmax = 20

deltat = 5

r = 0.03

p0 = 10

p1 = 0.3

p2 = 10

v0 = 0

v1 = 5

Landv = 50

```
FOR t = 0 TO 100
    FOR i = 0 TO 10
        f(t, i) = 0
        u(t, i) = 0
    NEXT i
NEXT t
```

```
FOR i = 1 TO 9
    u(tmax, i) = 1
NEXT i
```

```
REM boundary conditions at tmax
t = tmax * deltat
vol = v0 + v1 * t
FOR i = 1 TO 9
    netp = p0 + p1 * t + p2 * (i - 5)
    f(tmax, i) = EXP(-r * t) * (netp * vol + Landv)
    IF f(tmax, i) < 0 THEN f(tmax, i) = 0
NEXT i
```

```
REM FOR i = 1 TO 9
REM PRINT i; "   "; f(tmax, i)
REM NEXT i
```

REM Stochastic dynamic programming via backward recursion

```
FOR tindex = tmax - 1 TO 0 STEP -1
  t = tindex * deltat
  disc = EXP(-r * t)
  vol = v0 + v1 * t

  FOR i = 1 TO 9

    REM Objective function in case of no instant harvest
    fnoharv = 0
    FOR j = 1 TO 9
      fnoharv = fnoharv + DPProb(j) * f(tindex + 1, j)
    NEXT j

    REM Objective function in case of instant harvest

    netp = p0 + p1 * t + p2 * (i - 5)
    fharv = disc * (netp * vol + Landv)

    fopt = fharv
    IF fnoharv > fharv THEN fopt = fnoharv

    f(tindex, i) = fopt
    IF fopt = fharv THEN u(tindex, i) = 1
    IF f(tindex, i) < 0 THEN f(tindex, i) = 0

  NEXT i
NEXT tindex
```

On the following pages, we find these rows in larger size.

```
REM Stochastic dynamic programming via backward recursion

FOR tindex = tmax - 1 TO 0 STEP -1
    t = tindex * deltat
    disc = EXP(-r * t)
    vol = v0 + v1 * t
```

```
FOR i = 1 TO 9

    REM Objective function in case of no instant harvest
    fnoharv = 0
    FOR j = 1 TO 9
        fnoharv = fnoharv + DPProb(j) * f(tindex + 1, j)
    NEXT j
```

REM Objective function in case of instant harvest

netp = p0 + p1 * t + p2 * (i - 5)
fharv = disc * (netp * vol + Landv)

```
fopt = fharv
        IF fnoharv > fharv THEN fopt = fnoharv

        f(tindex, i) = fopt

        IF fopt = fharv THEN u(tindex, i) = 1

        IF f(tindex, i) < 0 THEN f(tindex, i) = 0

    NEXT i
NEXT tindex
```

```
REM Result tables

FOR tindex = 0 TO tmax

    t = tindex * deltat
    PRINT " Year = "; t
    PRINT ""
    PRINT "       Net Price   Harvest (1=Yes,0=N0)  Expected Present Value"
    PRINT #1, " Year = "; t
    PRINT #1, “”
    PRINT #1, "       Net Price   Harvest (1=Yes,0=N0)  Expected Present Value"
```

```
FOR i = 1 TO 9
    netp = p0 + p1 * t + p2 * (i - 5)
    harvest = u(tindex, i)
    fopt = f(tindex, i)

    PRINT USING "################"; netp; harvest; fopt;
    PRINT "”

    PRINT #1, USING "################"; netp; harvest; fopt;
    PRINT #1, ""

  NEXT i
```

```
INPUT z
    PRINT ""
    PRINT #1, ""
NEXT tindex

CLOSE #1
```

Harvest optimization via stochastic dynamic programming

Peter Lohmander Example 1 2017-10-15

Year = 0

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-30	0	2772
-20	0	2772
-10	0	2772
0	0	2772
10	0	2772
20	0	2772
30	0	2772
40	0	2772
50	0	2772

Year = 5

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-29	0	2772
-19	0	2772
-9	0	2772
2	0	2772
12	0	2772
22	0	2772
32	0	2772
42	0	2772
52	0	2772

Year = 10

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-27	0	2772
-17	0	2772
-7	0	2772
3	0	2772
13	0	2772
23	0	2772
33	0	2772
43	0	2772
53	0	2772

Year = 15

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-26	0	2772
-16	0	2772
-6	0	2772
5	0	2772
15	0	2772
25	0	2772
35	0	2772
45	0	2772
55	0	2772

Year = 20

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-24	0	2762
-14	0	2762
-4	0	2762
6	0	2762
16	0	2762
26	0	2762
36	0	2762
46	0	2762
56	1	3101

Year = 25

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-23	0	2735
-13	0	2735
-2	0	2735
8	0	2735
18	0	2735
28	0	2735
38	0	2735
48	1	2828
58	1	3419

Year = 30

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-21	0	2684
-11	0	2684
-1	0	2684
9	0	2684
19	0	2684
29	0	2684
39	0	2684
49	1	3009
59	1	3618

Year = 35

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-20	0	2617
-10	0	2617
1	0	2617
11	0	2617
21	0	2617
31	0	2617
41	0	2617
51	1	3110
61	1	3722

Year = 40

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-18	0	2537
-8	0	2537
2	0	2537
12	0	2537
22	0	2537
32	0	2537
42	1	2545
52	1	3147
62	1	3750

Year = 45

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-17	0	2438
-6	0	2438
4	0	2438
14	0	2438
24	0	2438
34	0	2438
44	1	2550
54	1	3134
64	1	3717

Year = 50

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-15	0	2327
-5	0	2327
5	0	2327
15	0	2327
25	0	2327
35	0	2327
45	1	2521
55	1	3079
65	1	3637

Year = 55

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-13	0	2207
-3	0	2207
7	0	2207
17	0	2207
27	0	2207
37	0	2207
47	1	2465
57	1	2994
67	1	3522

Year = 60

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-12	0	2080
-2	0	2080
8	0	2080
18	0	2080
28	0	2080
38	0	2080
48	1	2389
58	1	2884
68	1	3380

Year = 65

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-10	0	1951
-0	0	1951
10	0	1951
20	0	1951
30	0	1951
40	0	1951
50	1	2296
60	1	2758
70	1	3221

Year = 70

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-9	0	1822
1	0	1822
11	0	1822
21	0	1822
31	0	1822
41	0	1822
51	1	2192
61	1	2621
71	1	3049

Year = 75

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-7	0	1693
3	0	1693
13	0	1693
23	0	1693
33	0	1693
43	0	1693
53	1	2080
63	1	2476
73	1	2871

Year = 80

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-6	0	1556
4	0	1556
14	0	1556
24	0	1556
34	0	1556
44	1	1601
54	1	1964
64	1	2327
74	1	2690

Year = 85

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-4	0	1405
6	0	1405
16	0	1405
26	0	1405
36	0	1405
46	1	1514
56	1	1846
66	1	2178
76	1	2509

Year = 90

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-3	0	1232
7	0	1232
17	0	1232
27	0	1232
37	0	1232
47	1	1425
57	1	1727
67	1	2030
77	1	2332

Year = 95

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
-1	0	998
9	0	998
19	0	998
29	0	998
39	1	1061
49	1	1335
59	1	1610
69	1	1885
79	1	2160

Year = 100

Net Price	Harvest (1=Yes,0=NO)	Expected Present Value
0	1	2
10	1	251
20	1	500
30	1	749
40	1	998
50	1	1247
60	1	1496
70	1	1745
80	1	1994

Workshop References

The following literature and presentations will be used as background to the workshop sessions. In the schedule, the references of relevance to each session are printed.

[1] Lohmander, P., **Continuous extraction under risk**, IIASA, International Institute for Applied Systems Analysis, Systems and Decisions Sciences, WP-86-16, March 1986
http://www.iiasa.ac.at/Admin/PUB/Documents/WP-86-016.pdf
http://www.lohmander.com/WP-86-016.pdf

[2] Lohmander, P., **Pulse extraction under risk and a numerical forestry application**, IIASA, International Institute for Applied Systems Analysis, Systems and Decisions Sciences, WP-87-49, June 1987
http://www.iiasa.ac.at/Admin/PUB/Documents/WP-87-049.pdf
http://www.lohmander.com/WP-87-049.pdf

[3] Lohmander, P., **Continuous extraction under risk**, SYSTEMS ANALYSIS - MODELLING - SIMULATION, Vol. 5, No. 2, 131-151, 1988
http://www.Lohmander.com/PL_SAMS_5_2_1988.pdf

[4] Lohmander, P., **Pulse extraction under risk and a numerical forestry application**, SYSTEMS ANALYSIS - MODELLING - SIMULATION, Vol. 5, No. 4, 339-354, 1988
http://www.Lohmander.com/PL_SAMS_5_4_1988.pdf

[5] Lohmander, P., **Continuous harvesting with a nonlinear stock dependent growth function and stochastic prices: Optimization of the adaptive stock control function via a stochastic quasi-gradient method**, Swedish University of Agricultural Sciences, Dept. of Forest Economics, No. 144, 1992
http://www.Lohmander.com/Lohmander_R144_1992.pdf

[6] Lohmander, P., **Continuous harvesting with a nonlinear stock dependent growth function and stochastic prices: Optimization of the adaptive stock control function via a stochastic quasi-gradient method**, in: Hagner, M. (editor), Silvicultural Alternatives, Proceedings from an internordic workshop, June 22-25, 1992, Swedish University of Agricultural Sciences, Dept. of Silviculture, No. 35, 198-214, 1992
http://www.Lohmander.com/Lohmander_SilvAlt_1992.pdf

[7] Lohmander, P., **The multi species forest stand, stochastic prices and adaptive selective thinning**, SYSTEMS ANALYSIS - MODELLING - SIMULATION, Vol. 9, 229-250, 1992
http://www.Lohmander.com/PL_SAMS_9_1992.pdf

[8] Lohmander, P., **Economic two stage multi period species management in a stochastic environment: The value of selective thinning options and stochastic growth parameters**, SYSTEMS ANALYSIS - MODELLING -SIMULATION, Vol. 11, 287-302, 1993
http://www.Lohmander.com/PL_SAMS_11_1993.pdf

[9] Lohmander, P., **Optimal sequential forestry decisions under risk**, ANNALS OF OPERATIONS RESEARCH, Vol. 95, pp. 217-228, 2000
http://www.Lohmander.com/PL_AOR_95_2000.pdf

[10] Lohmander, P., **Adaptive Optimization of Forest Management in a Stochastic World**, in Weintraub A. et al (Editors), Handbook of Operations Research in Natural Resources, Springer, Springer Science, International Series in Operations Research and Management Science, New York, USA, pp 525-544, 2007
http://www.amazon.ca/gp/reader/0387718141/ref=sib_dp_pt/701-0734992-1741115#reader-link
http://www.Lohmander.com/PL_Handbook2007.pdf

[11] Mohammadi, L.S., Lohmander, P., **Stumpage Prices in the Iranian Caspian Forests**, Asian Journal of Plant Sciences, 6 (7): 1027-1036, 2007, ISSN 1682-3974, 2007 Asian Network for Scientific Information, http://ansijournals.com/ajps/2007/1027-1036.pdf
http://www.Lohmander.com/MoLo2007.pdf

[12] Lohmander, P., Mohammadi, S., **Optimal Continuous Cover Forest Management in an Uneven-Aged Forest in the North of Iran**, Journal of Applied Sciences 8(11), 2008 http://ansijournals.com/jas/2008/1995-2007.pdf
http://www.Lohmander.com/LoMoOCC.pdf

[13] Lohmander, P., **Guidelines for Economically Rational and Coordinated Dynamic Development of the Forest and Bio Energy Sectors with CO2 constraints**, Proceedings from the 16th European Biomass Conference and Exhibition, Valencia, Spain, 02-06 June, 2008 (In the version in the link, below, an earlier misprint has been corrected.) http://www.Lohmander.com/Valencia2008.pdf

[14] Lohmander, P., **Software for illustration of the CO2 and forest management issue in combination with CCS technology**, 2008, *http://www.lohmander.com/co2ill2/co2ill2.htm*

[15] Lu, F., Lohmander, P., **Optimal Decisions for Mixed Forests under Risk**, Scientia Silvae Sinicae, Vol. 45, No. 11, Nov. 2009
http://www.Lohmander.com/Lu_Lohmander_2009.pdf

[16] Lohmander, P., Zazykina, L., **Rational and sustainable utilization of forest resources with consideration of recreation and tourism, bioenergy, the global warming problem, paper pulp and timber production: A mathematical approach**, Proceedings of the II international workshop on Ecological tourism, Trends and perspectives on development in the global world, Saint Petersburg Forest Technical Academy, April 15-16, 2010
http://www.Lohmander.com/SPb201004/Lohmander_Zazykina_SPbFTA_2010.pdf
http://www.Lohmander.com/SPb201004/Lohmander_Zazykina_SPbFTA_2010.doc
http://www.Lohmander.com/SPb201004/PPT_Lohmander_Zazykina_SPbFTA_2010.ppt
http://www.Lohmander.com/SPb201004/PPT_Lohmander_Zazykina_SPbFTA_2010.pdf

[17] Lohmander, P., Zazykina, L., **Methodology for optimization of continuous cover forestry with consideration of recreation and the forest and energy industries**, Report and Abstract, Forests of Eurasia, Publishing House of Moscow State Forest University, September 19 - 25, 2010
http://www.lohmander.com/Moscow10/Moscow10_PL_LZ.pdf
http://www.lohmander.com/Moscow10/Moscow10_PL_LZ.doc
http://www.lohmander.com/Moscow_PL_2010.pdf
http://www.lohmander.com/Moscow_2010/Lohmander_Zazykina_Moscow_2010.ppt
http://www.lohmander.com/Moscow_2010/Programma-LE_10_01.doc

[18] Lohmander, P., Zazykina, L., **Dynamic economical optimization of sustainable forest harvesting in Russia with consideration of energy, other forest products and recreation**, SSAFR-2011, 14th Symposium for Systems Analysis in Forestry, Abstracts, Maitencillo, Chile, March 8-11, 2011,
http://www.lohmander.com/Chile_2011/Chile_2011_Dynamic_Lohmander.ppt

[19] Lohmander, P., **With expanded bioenergy based on forest resources, we may simultaneously and sustainably reduce global warming, improve economic results, international relations and environmental conditions**, BIT'S 4th Annual World Congress of Bioenergy-2014, Qingdao International Convention Center, China
http://www.Lohmander.com/PLWCBE2014A.pptx
http://www.Lohmander.com/PLWCBE2014A.pdf
http://www.Lohmander.com/WCBE2014_Expansion.pdf
http://www.bitcongress.com/wcbe2014/

[20] Mohammadi Limaei, S., Lohmander, P., Olsson, L., **Sub models for optimal continuous cover multi species forestry in Iran**, The 8th International Conference of Iranian Operations Research Society, Department of Mathematics, Ferdowsi University of Mashhad, Mashhad, Iran, 21-22 May 2015
http://www.Lohmander.com/SML_PL_LO_IRAN_ABS_2015.pdf
http://www.Lohmander.com/PL_IRAN_B_2015.pdf
http://www.Lohmander.com/PL_IRAN_B_2015.pptx
http://www.Lohmander.com/PL_OR8_Abs_15.pdf
http://www.or8.um.ac.ir

[21] Lohmander, P., **Applications and mathematical modeling in operations research, KEYNOTE**, International Conference on Mathematics and Decision Science, International Center of Optimization and Decision Making & Guangzhou University, Guangzhou, China, September 12-15, 2016
http://www.Lohmander.com/PL_KEYNOTE_MATH_2016.jpg
http://www.Lohmander.com/PL_ICODM_2016_KEY.pptx
http://www.Lohmander.com/PL_ICODM_2016_KEY.pdf
http://www.Lohmander.com/PL_ICODM_2016_KEY_PAPER.pdf
http://www.Lohmander.com/PL_ICODM_2016_KEY_PAPER.docx
http://icodm2020.com/en/

[22] Lohmander, P., **Optimal stochastic control of spatially distributed interdependent production units**, International Conference on Mathematics and Decision Science, International Center of Optimization and Decision Making & Guangzhou University, Guangzhou, China, September 12-15, 2016
http://www.Lohmander.com/PL_BEST_PAPER_AWARD_MATH_2016.jpg
http://www.Lohmander.com/PL_ICODM_2016_CCF.pptx
http://www.Lohmander.com/PL_ICODM_2016_CCF.pdf
http://www.Lohmander.com/PL_ICODM_2016_CCF_PAPER.pdf
http://www.Lohmander.com/PL_ICODM_2016_CCF_PAPER.docx
http://icodm2020.com/en/

[23] Lohmander, P., **A general dynamic function for the basal area of individual trees derived from a production theoretically motivated autonomous differential equation**, National Conference on the Caspian Forests of Iran, "Past, Current, Future", University of Guilan, Rasht, Iran, April 26-27, 2017
http://www.Lohmander.com/PPT_GUILAN_PL_DIFF_2017.pptx
http://www.Lohmander.com/PPT_GUILAN_PL_DIFF_2017.pdf
http://www.Lohmander.com/Paper_Guilan_Dynamic_170215.pdf
http://www.Lohmander.com/Paper_Guilan_Dynamic_170215.docx
http://conf.isc.gov.ir/forestnorth

[24] Hatami, N., Lohmander, P., Moayeri, M.H., Mohammadi Limaei, S., **A basal area increment model for individual trees in mixed species continuous cover stands in Iranian Caspian forests**, National Conference on the Caspian Forests of Iran, "Past, Current, Future", University of Guilan, Rasht, Iran, April 26-27, 2017
http://www.Lohmander.com/PPT_GUILAN_JOINT_2017.ppt
http://www.Lohmander.com/PPT_GUILAN_JOINT_2017.pdf
http://www.Lohmander.com/Paper_Guilan_joint_170321.pdf
http://www.Lohmander.com/Paper_Guilan_joint_170321.docx
http://conf.isc.gov.ir/forestnorth

[25] Lohmander, P., **Optimal stochastic control in continuous time with Wiener processes: - General results and applications to optimal wildlife management, KEYNOTE**, The 10th International Conference of Iranian Operations Research Society, Balbosar, Iran, May 3-5, 2017
http://www.Lohmander.com/PPT_OR10_PL_KEYNOTE_2017.pptx
http://www.Lohmander.com/PPT_OR10_PL_KEYNOTE_2017.pdf
http://www.Lohmander.com/Paper_OR10_KEYNOTE_170127.pdf
http://www.Lohmander.com/Paper_OR10_KEYNOTE_170127.docx
http://www.icordm.ir/en/index.php

[26] Lohmander, P., **ICMDS 2016 Conference report**, Fuzzy Information and Engineering, Elsevier, Vol. 9, Issue 2, June 2017
https://authors.elsevier.com/sd/article/S1616865817301486

[27] Lohmander, P., Olsson, J.O., Fagerberg, N., Bergh, J., Adamopoulos, S., **High resolution adaptive optimization of continuous cover spruce forest management in southern Sweden**, SSAFR 2017, Symposium on Systems Analysis in Forest Resources, Clearwater Resort, Suquamish, Washington, (near Seattle), August 27-30, 2017
http://www.Lohmander.com/SSAFR_2017_Lohmander_et_al.pptx
http://www.Lohmander.com/SSAFR_2017_Lohmander_et_al.pdf
http://www.Lohmander.com/SSAFR_2017_Lohmander_Soft.txt
SSAFR 2017

[28] Lohmander, P., **Applications and Mathematical Modeling in Operations Research**, In: Cao BY. (ed) Fuzzy Information and Engineering and Decision. IWDS 2016. Advances in Intelligent Systems and Computing, vol 646. Springer, Cham, 2018,

Print ISBN 978-3-319-66513-9, Online ISBN 978-3-319-66514-6, eBook Package: Engineering, LAMMOR, https://doi.org/10.1007/978-3-319-66514-6_5

[29] Lohmander, P., **Optimal Stochastic Dynamic Control of Spatially Distributed Interdependent Production Units**. In: Cao BY. (ed) Fuzzy Information and Engineering and Decision. IWDS 2016. Advances in Intelligent Systems and Computing, vol 646. Springer, Cham, 2018
Print ISBN 978-3-319-66513-9, Online ISBN 978-3-319-66514-6, eBook Package: Engineering, LOSDCSDI, https://doi.org/10.1007/978-3-319-66514-6_13