Epidemiological models

Model SIS

Symbol	Importance	Value	Units	
S	**population susceptible to infection**	199990	ind	Variab
I	infested population	10	ind	
a	rate of recovery from illness	0.018	$time^{-1}$	Param
r	rate of spread infection	$1.5 \cdot 10^{-6}$	$time^{-1}$	

Differential equations:
$S'(t) = a \cdot I(t) - r \cdot S(t) \cdot I(t)$
$I'(t) = r \cdot S(t) \cdot I(t) - a \cdot I(t)$

Determination of character of an epidemy
$\rho = 0.18/0.0000015 = 120\,000 < S(0) = 199990$ i.e. epidemic isn't spreading

To stop spreading the infection healing rate should be changed to make I'=0. I. e.:
$0 = r \cdot S(t) \cdot I(t) - a \cdot I(t)$
$a \cdot I(t) = r \cdot S(t) \cdot I(t)$
$a = r \cdot S(t)$
$a = 0.0000015 \cdot 199990 = 0.3$, while current is 0.18

Population constantly susceptible means that S'=0.
$r \cdot S(t) \cdot I(t) - a \cdot I(t) = 0$
$S(t) = a/r = \rho = 0.18/0.0000015 = 120\,000$

Figure 1: constant number of healthy people

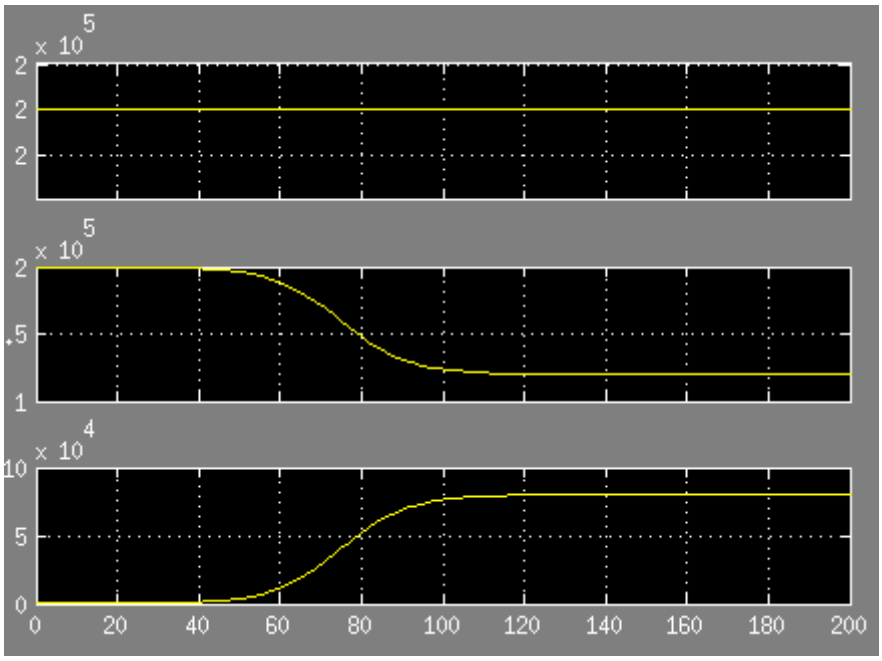


Figure 2: Recovery of population and stopping the epedemy.

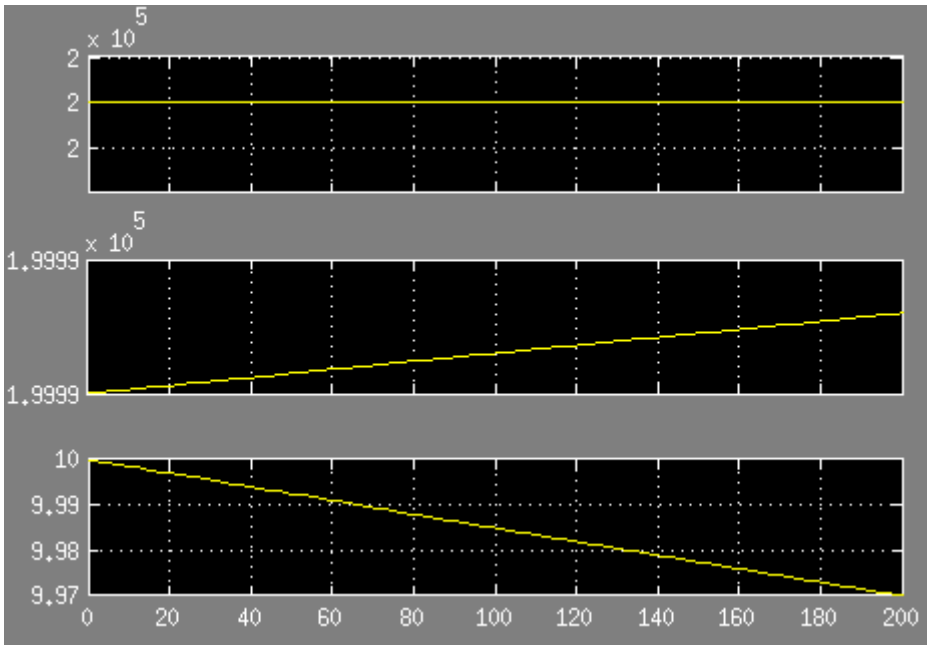
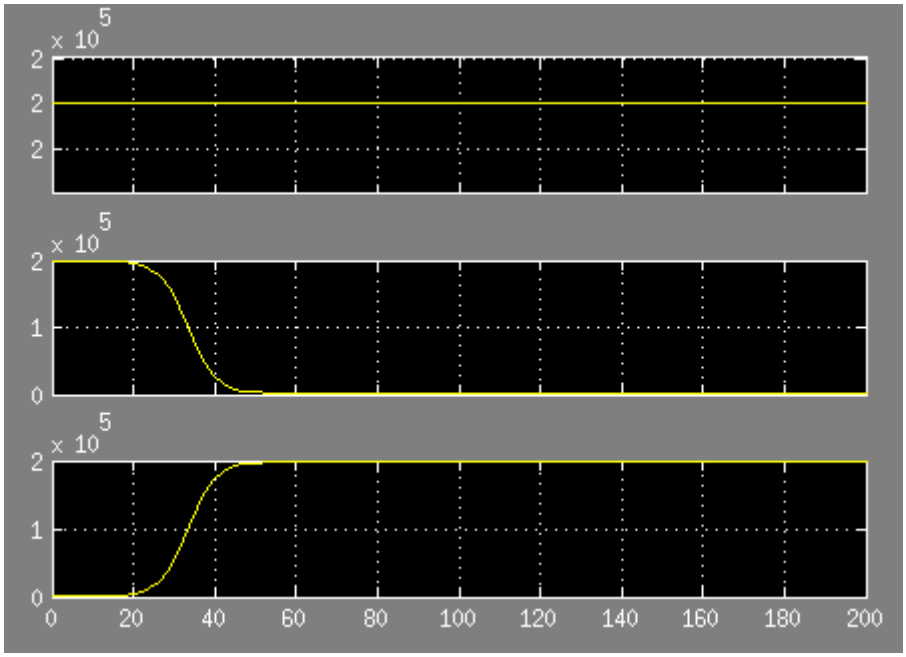


Figure3: Epidemic break out.



Model SIR & SIRV

Symbol	Importance	Value	Units	
S	**population susceptible to infection**	99	ind	Variables
I	infested population	1	ind	
R	died individuals	0	ind	
V	vaccinated individuals	0	ind	Parameters
a	virus death rate	0.5	$time^{-1}$	
r	rate of spread infection	0.01018	$time^{-1}$	
N	number of vaccination	5	$time^{-1}$	

Differential equations for model without vaccination

$S'(t) = -r \cdot S(t) \cdot I(t)$

$I'(t) = r \cdot S(t) \cdot I(\tilde{t}) - a \cdot I(t)$

$R'(t) = a \cdot I(t)$

Differential equations for model with vaccination

$S'(t) = -r \cdot S(t) \cdot I(t) - N$

$I'(t) = r \cdot S(t) \cdot I(t) - a \cdot I(t)$

$R'(t) = a \cdot I(t)$

$V'(t) = N$

Figure 4: illustration of a herd prospect without vaccination

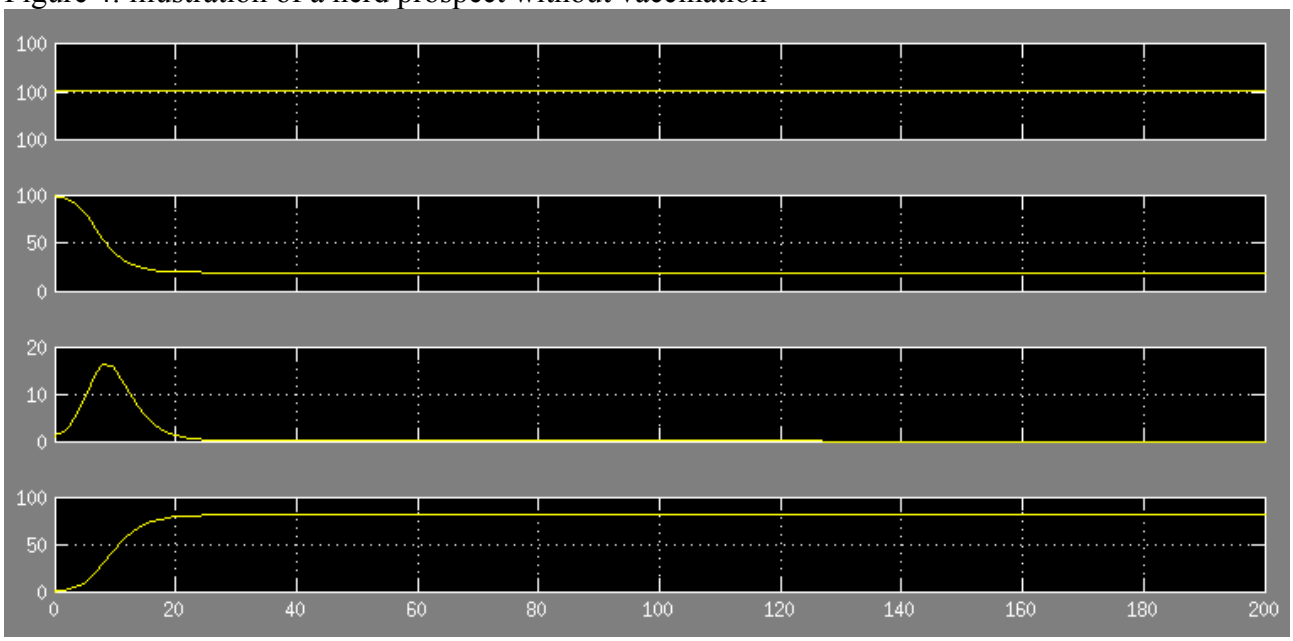
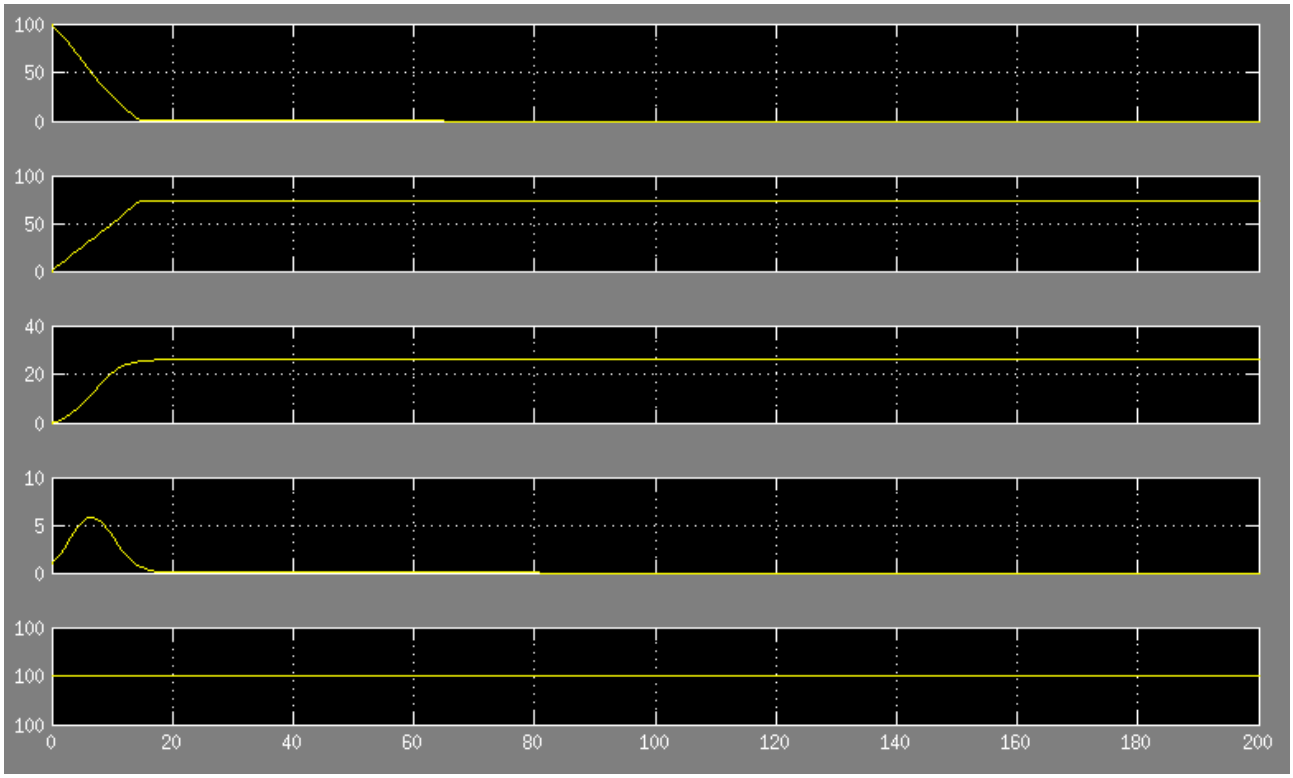


Figure 5: illustration of a herd prospect with vaccination



If farmer don't use vaccination only 19 cows will survive.
If he starts vaccination he will save 74 cows and spend 74·840 = 62160 CZK.